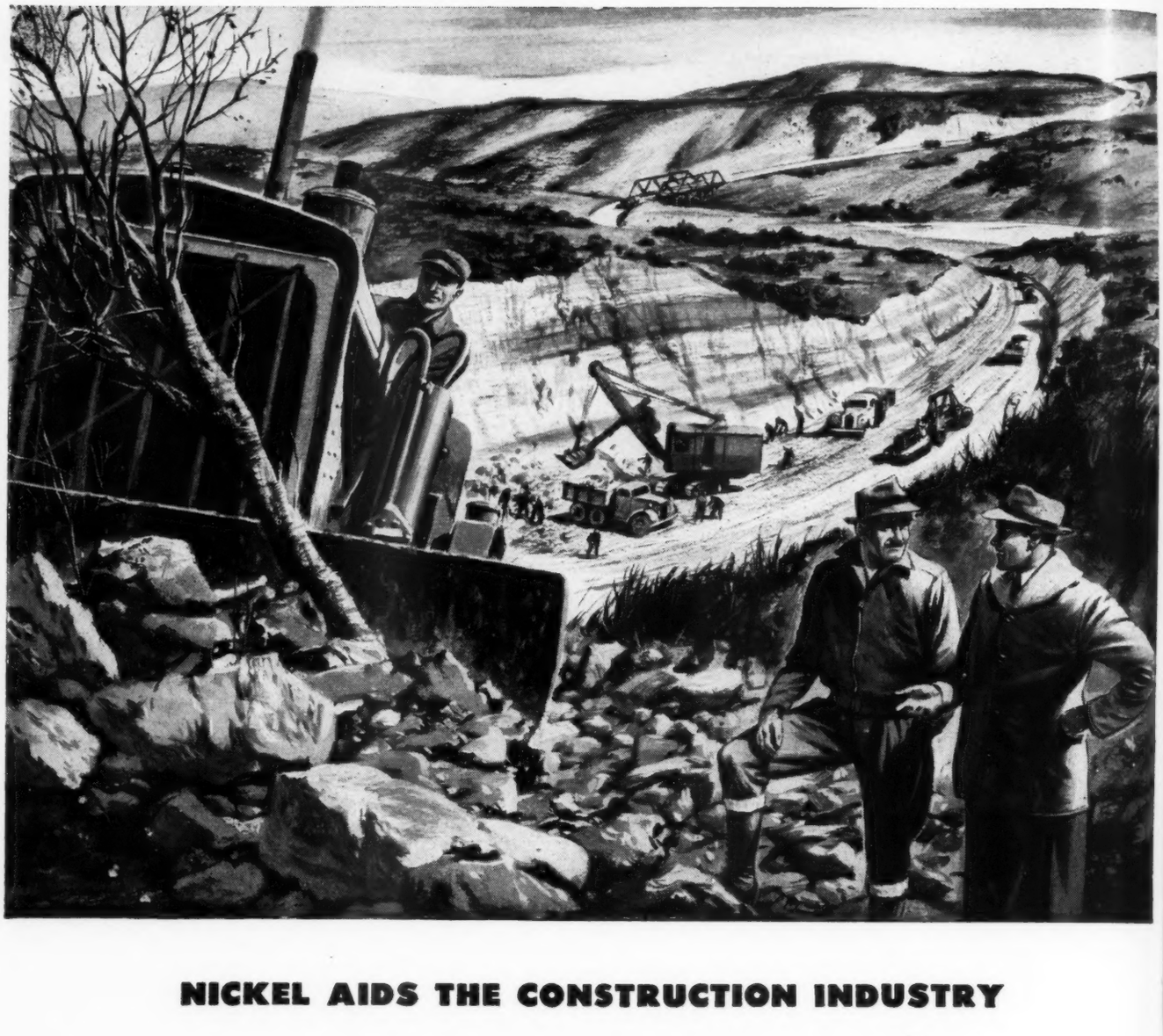
PRODUCT ENGINEERING

DECEMBER, 1943



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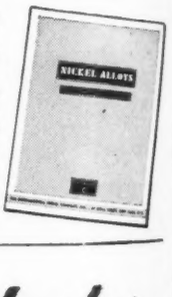

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PRODUCT ENGINEERING

VOLUME XIV — DECEMBER, 1943 — NUMBER 12

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Subscribers may encounter delay in receiving their copies of Product Engineering. Such delay is caused by wartime strain on transportation and postal systems, a situation beyond the Publisher's control.

IN THIS ISSUE

Cover Picture

A closeup of the new Emerson-powered gun turret, which can revolve in a wide arc, is shown in the nose of a Liberator bomber. The bombardier's station remains in the nose.

Special Section: Electric Motors

Fourth in the series of 16-page editorial surveys covering materials, parts and processes which are of essential interest to engineers and designers, PRODUCT ENGINEERING presents a review of recent trends and developments in the design of and applications for electric motors. The summary includes diminutive motors, aircraft accessory motors, high-frequency motors, partial motors and integral horsepower motors. Although many of the types described have evolved from the demand for special requirements imposed by military applications, they offer many opportunities for incorporation in post-war design of products and industrial equipment.

Aircraft Conservation Program

A welter of confusion and duplication was dissipated with the organization late in 1942 of the Operating Committee on Aircraft Materials Conservation. Composed of representatives of the Army, Navy and War Production Board, the committee launched a coordinated program which

brought relief to designers and production men previously harassed by directives from separate agencies working at cross-purposes. Details of the committee's formation, its membership and projected program of conservation appear on pages 755 to 759.

Electronic Controls

Present applications of electronics in industry indicate a broad potential field for designers. Some industrial applications embodying electronic controls for machinery are described by A. E. Bailey, Jr., of the General Electric Company, in an article on page 760. Design precautions which must be observed when incorporating electronic control devices in machines are emphasized.

Aircraft Accessory Systems

Electrical or hydraulic accessory systems in aircraft represent an issue which has created two schools of thought among design engineers. The most ardent supporters of hydraulic systems will admit that electrical systems have made tremendous strides under the influence of war. Realizing that the pros and cons of the two systems form interesting material for design engineers, PRODUCT ENGINEERING sought the unbiased views of two eminent engineers, C. J. Breitwieser and C. B. Livers of the Consolidated Vultee Aircraft Corporation. Mr. Breitwieser elected to support electrical systems and his article appears on page 778. Mr. Livers espouses the cause of hydraulic systems and his views will be presented next month.

Black Coatings For Non-Ferrous Metals

Non-ferrous metals in much war equipment have been more serviceable through application of black coatings. New blackening processes have proved particularly useful for marine products, and for war instruments which must be glare-proof and able to withstand deteriorating elements in service. Dr. Walter R. Meyer, technical director of Enthrone Company, discusses on page 792 the characteristics of each of the four basic types of black coatings available for non-ferrous metals.

Testing Aluminum Parts

Continuing his review of improved testing methods, Russell G. Anderson of the Aluminum Company of America, describes in an article on page 786 the technique for determining by hardness tests the temperature to which aluminum parts have been exposed in service. The procedure, applicable to any machine subject to high operating temperatures, enables designers to improve temperature conditions and determine the highest usable working stresses.

Dimensioning in Perspective

One of the sidelights of the series of articles that has been running in PRODUCT ENGINEERING on graphic illustration (March, p. 131-137 and June, p. 366-369) is the proper way to put dimensions on perspective drawings. Principles for dimensioning perspective drawings follow in general those for dimensioning orthographic drawings. To aid members of the graphic illustration department of Fleetwings Division of Kaiser Cargo, Inc., in their work, a section has been prepared for the drafting-room manual that explains the principles of dimensioning in perspective. These principles are given on pages 790 and 791, together with examples of correct and incorrect practices.

Post-War Product Development

Assembled at a recent meeting in Cleveland, Ohio, 16 chief engineers discussed programs involving industry's transition from all-out war production to the development and manufacture of peacetime goods. The problems and solutions presented at the session are summarized in an article on page 774. This supplements an article based on the same meeting and entitled, "Manpower Problems in the Engineering Department," which appears on page 704 of the November number of PRODUCT ENGINEERING.

Stress Formulas For Non-Homogeneous Beams

Recent developments and improvements in the techniques of bonding and cladding together unlike engineering materials, have made available opportunities for engineers to obtain more efficient use of materials in their products by employing composite designs. When combinations of materials are used in parts which are subjected to bending and shear loads, George W. DeBell, see page 782, lists a number of formulas for calculating effective section and material properties for design purposes.

Production Metal Spraying

Metal spraying has made rapid strides during the war years and is destined for wider use as a production method. The metallizing process has worked to good advantage in conserving critical materials and it holds an important place as a replacement for tinning, galvanizing, calorizing, electroplating, and welding under certain conditions. An article on page 795 describes applications to metals and other materials.

Tentative Gear Standard

A.G.M.A. standard for 20-degree involute fine pitch system for spur gears, see page 823, approved as a tentative standard by the American Gear Manufacturers Association.

WHAT'S COMING

Cycle-Welding

Bonding of dissimilar materials such as metal to wood, wood to glass or plastics to metal is now possible through the use of the Cycle-Welding process. As knowledge of the various cements and techniques increases engineers will have opportunities to develop composite structures tailored to specific design requirements. The Cycle-Weld bonding method was developed jointly by engineers of the Chrysler Corporation and Goodyear Tire and Rubber Co. Today it is extensively used in secret military and aircraft structural applications. In a forthcoming article, PRODUCT ENGINEERING will present a comprehensive analysis of the process and its applications together with data on the forms in which Cycle-Welding is available and engineering information on design criteria.

Special Section: Inorganic Finishes

Shortages of critical wartime materials have accelerated developments in porcelain enamel and other such inorganic finishes and in electroplating. New formulations, improved techniques have led to many varied and interesting applications to wartime products. In the next issue PRODUCT ENGINEERING presents an editorial summary highlighting these developments in inorganic finishes and electroplating. These developments will be described and typical applications illustrated. This 16-page report is the fifth in PRODUCT ENGINEERING's series of inserts planned to help in adapting new processes, materials and parts to post-war designs.

PRODUCT ENGINEERING
DECEMBER, 1943

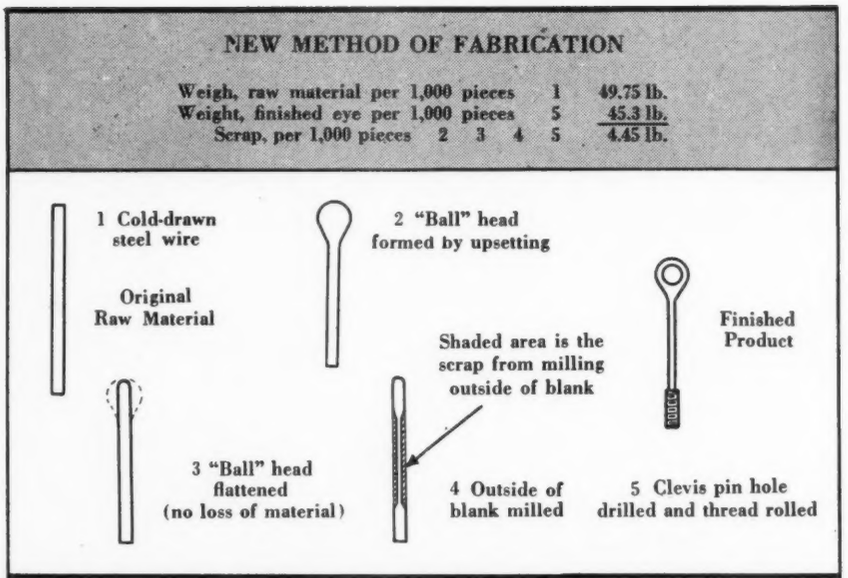
Coordinated Program Conserves Aircraft Materials

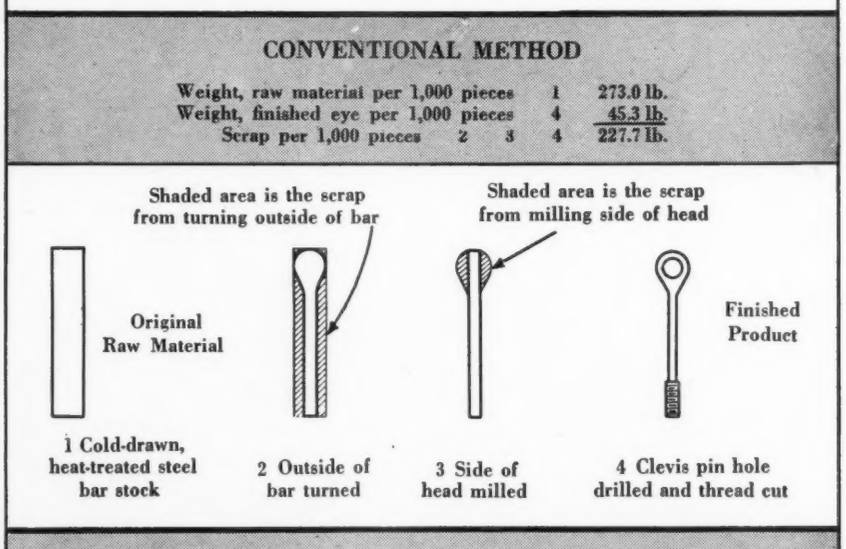
An Operating Committee of Army, Navy and WPB representatives furthers the standardization program, disseminates important information and test data. Details of the committee's organization, its membership and scope of work are presented. Examples of recent directives and bulletins are cited.

Coordinated action is the theme of this typical session of the Operating Committee on Aircraft Materials Conservation. Reading around the table from left to right are: G. D. Taylor of ARCO Conservation Division; N. E. Promisel, Chief Metallurgist, Navy Bureau of Aeronautics; Lieutenant Colonel Norris Kenny, Army Service Forces; Lieutenant O. C. Roehl, USNR, Navy Office of Procurement and Material, Operating Committee Recorder; C. E. Stryker, Chief, Conservation and Standards Division of ARCO; Major R. R. Gridley, Chief of Conservation Branch, Army Air Staff, Washington; Major L. A. Bernier (back to camera) Chief of Conservation Section, Army Air Forces Materiel Command, Wright Field.

THE story of wartime Washington as it is told daily in the dispatches of news writers, the "think" pieces of columnists and the commentaries of radio news analysts, relates of confusion and duplication of effort, of organizations working at cross purposes, of complicated questionnaires and forms, of wrangling over divided authority, and, in some instances, of bedlam at the nerve center of the war effort.

This picture is by no means untrue, but it is inaccurate. It will always be so, for the fact that confusion exists is always a newsier story than the


NEW METHOD OF FABRICATION
Weigh, raw material per 1,000 pieces 1 49.75 lb.
Weight, finished eye per 1,000 pieces 5 45.3 lb.
Scrap, per 1,000 pieces 2 3 4 5 4.45 lb.
1 Cold-drawn steel wire
Original Raw Material
2 "Ball" head formed by upsetting
3 "Ball" head flattened (no loss of material)
Shaded area is the scrap from milling outside of blank
4 Outside of blank milled
5 Clevis pin hole drilled and thread rolled
Finished Product


CONVENTIONAL METHOD
Weight, raw material per 1,000 pieces 1 273.0 lb.
Weight, finished eye per 1,000 pieces 4 45.3 lb.
Scrap per 1,000 pieces 2 3 4 227.7 lb.
Shaded area is the scrap from turning outside of bar
Shaded area is the scrap from milling side of head
Original Raw Material
1 Cold-drawn, heat-treated steel bar stock
2 Outside of bar turned
3 Side of head milled
4 Clevis pin hole drilled and thread cut
Finished Product
Scrap, per 1,000 pieces, Conventional Method 227.7 lb.
Scrap, per 1,000 pieces, New Method 4.45 lb.
Saving, per 1,000 pieces 223.25 lb.

Old and new methods for production of turnbuckle eye. This is a sample of the type of manufacturing improvement for which the committee is looking. Projects such as these are studied by the Services and either accepted or rejected.

fact that an organization is doing its job accurately, efficiently and quietly. There are many of the latter organizations in Washington. Chief among them is the Operating Committee on Aircraft Materials Conservation, a joint Army - Navy - War Production Board agency which emerged from a cauldron of confusion.

In 1940, when the President called for 50,000 airplanes for national defense, it was obvious that "made-to-order" practices of the aircraft industry would have to be adapted to the mass-production techniques of the automobile and similar industries if there was to be anything approximating sufficient aerial might to defend the nation or prosecute the war which was growing closer daily.

What attempts were made to stem or regulate the inevitable confusion when it first arose have since become obscured or lost. Probably little could have been done in the early days of the defense program because the problem was then growing from day to day and it was easier to reach solutions than it is now. For example, in the early days Selective Service was taking only single men and few over the age of twenty-eight. There was a pool of unemployed workers upon which to draw. Was a plant needed? Then build one. Was it materials? Order them, and they'll be here by the time they're needed. That was the way to push plane production up by 100 units a month two or more years ago.

Early Cooperation by the Services

Army and Navy men, who had to fight whatever war was to come, were not so blithe, however. During World War I a "Joint Army-Navy Board on Aeronautic Cognizance" was established. This later grew into the present Aeronautical Board which operates under direction and supervision of the President, and was organized for the purpose of securing a more complete measure of cooperation and coordination in the development of aviation of the Army and Navy.

The Army and Navy knew the difficulties of supply and coveted the values of standardization, interchangeability and simplification. Thus, as early as 1937, the old Army Air Corps and the Navy's Bureau of Aeronautics were working out these possibilities jointly. By 1940 they had agreed upon common and binding specifications for many items used by both Services. The Army was taking the Navy's inspection of Pratt and Whitney engines, and the Navy accepted the Army's inspection of Wright engines. Other projects had been worked out and still others were in the mill.

Heading this early coordination of effort in the aircraft specifications and standards field were Captain A. M. Pride, USN, of the Bureau of Aeronautics, and Colonel D. G. Lingle of the Army Air Corps (PRODUCT ENGINEERING, *November*, 1940, *page* 504). This work continues today under the sponsorship of the Working Committee of the Aeronautical Board.

As production grew, it was necessary to coordinate action on many new aircraft problems and one of these was aircraft material conservation. Throughout 1941 and 1942 the agencies dealing with aircraft supply and production and accordingly with aircraft material conservation mushroomed. The Army and Navy had many separate agencies working on the matter. OPM, SPAB, and finally WPB, which entered the picture early in 1942, had at least half a dozen agencies or committees dealing with aircraft production. The net result was duplication of effort, of research and testing, of records, and of reports.

The material problem became more pressing. Material substitutions became the order of the day and new methods designed to save materials, manpower and facilities became im-

erative. Directives marched and countermarched. Restrictions flowed out from half a dozen sources. Bulletins, suggestions, orders, plans, programs, questionnaires, forms, reports and schedules poured out of Washington and other centers in ever-increasing weight. Aircraft makers appealed for help, pointing out that conflicting directives didn't speed production but actually slowed or halted it until the conflict could be resolved.

Organization Steps Taken

Early in 1942, Admiral J. H. Towers, then Chief of the Bureau of Aeronautics, suggested to the Chief of the Navy's Office of Procurement and Material, Vice-Admiral S. M. Robinson, that steps be taken to set up "a single agency of Army, Navy and industrial representatives" to coordinate aircraft conservation activities. General F. M. Hopkins, Jr., also urged that aircraft conservation activities of the Army, Navy and WPB be correlated so that "dissemination of important information and test data can be efficiently accomplished and unwarranted duplication of effort avoided."

As it should to all such situations, death came to the muddle with the organization of the Operating Committee on Aircraft Materials Conservation late in 1942, representing the Army, Navy, and WPB, the latter through its Aircraft Production Division. Organization meetings were attended by men who had been in the thick of the fight to bring order out of chaos in similar situations involving aircraft problems.

Originally organized under sponsorship of the Aeronautical Board but later assigned to operate under the Aircraft Production Board, the committee began its functions even before a formal statement of its jurisdiction and procedure was ratified by the three cooperating agencies. As finally ratified, the purpose of the Operating Committee was outlined as follows:

"To work with the Resources Control Office of the Aircraft Production Board in providing such coordination of aircraft materials conservation activities of the Army Air Forces, the Navy Bureau of Aeronautics, and the War Production Board as may be found necessary to assure the effectiveness of these activities and to avoid conflict and duplication of effort."

Membership of the Operating Committee, formally established in early January, 1943, was broadened to include conservation representatives of the Working Committee of the Aeronautical Board, the Aircraft Scheduling Unit, the Army Service Forces and the Navy Office of Procurement and Material, the latter two holding liaison memberships. Shortly after the committee was organized, the Aircraft Production Board was set up within the War Production Board replacing the old Aircraft Production Division and the agency's executive office, the Aircraft Resources Control Office, was made a committee member to represent the divisions of the WPB. While the committee continues to work closely with the Aeronautical Board and utilize its facilities, it now reports to the Aircraft Production Board.

Each cooperating agency signed away a portion of its sovereignty to get, in return, the improved production possible only under coordinated, unanimous action toward the desired ends. Loss of sovereignty meant, for instance, that a WPB industry division could no longer issue a conservation directive to an aircraft manufacturer and expect him to comply with it. But it meant also that whenever a directive containing the points which the division wanted to enforce was issued by the new Operating Committee, it became the "law of the land," and there was no possibility of second-guessing by either of the Services. Increased aircraft production resulted.

Committee Members

Today the committee operates under direction of General Hopkins of the Army Air Forces, Commander J. E. Sullivan of the Bureau of Aeronautics, and T. P. Wright of the Aircraft Resources Control Office.

Committee representatives of various agencies follow: Army Air Forces—Major R. R. Gridley, Chief of Conservation Branch, Army Air Staff, Washington, D. C., and Major L. A. Bernier, Chief of Conservation Branch, Material Command, Wright Field, Dayton, Ohio; Navy Bureau of Aeronautics—Lieutenant Commander R. C. Hall, Chief of the Conservation Section, and N. E. Promisel, Chief

OUTLINE OF A CONSERVATION ACTIVITY
OF THE OPERATING COMMITTEE
ON AIRCRAFT MATERIALS CONSERVATION
IN COOPERATION WITH THE AIRCRAFT INDUSTRY

PROGRAM: To replace manufacturing processes resulting in excessive waste of materials, manpower and facilities with more efficient and economical methods.

BY ENCOURAGING USE OF: CASTINGS, permanent mold, die, centrifugal and sand; STAMPINGS, blanking, drawing and press forming; HEADING and UPSETTING; HOT PRESSING; PRE-FORMED MATERIALS, tubes, extrusions, and rolled sections; WELDED ASSEMBLIES; and other high production and high economy methods.

RELATED QUESTIONS:

1. **Can a standard part or material be used instead of a special?**
2. **Can savings be effected through redesign?**
3. **Can two or more parts more economically be made in one piece?**
4. **Can one part more economically be made in two or more pieces?**
5. **Can speeds or feeds be increased?**
6. **Can automatic or multiple spindle processes be used?**
7. **Can forging dies be redesigned to reduce slug weight?**
8. **Can clean-up tolerances be reduced?**
9. **Can more economical protective coating methods be utilized?**
10. **Can powder metallurgy be used?**

The above outlines the program now being developed by the Army, Navy, War Production Board and aircraft industry. Other committee programs include material substitutions, testing programs, reclamation, standardization and simplification.

Metallurgist, Bureau of Aeronautics, Washington, D. C.; War Production Board—C. E. Stryker, Chief of Conservation and Standards Division, Aircraft Resources Control Office; Aircraft Scheduling Unit — Lieutenant Colonel A. E. R. Peterka and Commander J. M. Weldon; Army Service Forces—Lieutenant Colonel Norris Kenny as liaison member; Working Committee of the Aeronautical Board —Lieutenant Commander A. M. Blamphin and Major G. R. Gaillard; Navy Office of Procurement and Material—Lieutenant O. C. Roehl.

Lieutenant Roehl serves as the committee's Recorder. The Recorder's office maintains the official files and records of the committee and is responsible for all actions concerning the coordination and publication of directives and bulletins.

Formation of a committee to coordinate all aircraft materials conservation work did not guarantee immediate and complete success of the project. The aircraft industry had to be informed and its cooperation obtained. Liaison was made with the industry through the National Aircraft War Production Council, the West Coast Aircraft War Production Council, the East Coast Aircraft War Production Council and the Central Aircraft Council and through the National Aircraft Standards Committee and the Society of Automotive Engineers.

The Operating Committee was given the power to issue directives which had to be followed if contracts were to be fulfilled. Thus the power of the purse proved to be about as much police power as the Operating Committee needed, for by the fall of 1942, there was only one customer for aircraft built in the United States. With that customer—the Army and Navy—subscribing to the directives of the Operating Committee, the need for compliance became almost automatic.

Bulletins Prove Helpful

The committee's dealings with the aircraft industry are not confined to directives. Numerous bulletins incorporating the results of tests, studies and surveys are sent out, none of them having more compulsion than any other suggestion. In almost every case, manufacturers are glad to go along with these suggestions because they offer means of improving production, and often of cutting costs, and because the methods are approved after careful testing and inspection by the contracting agencies. The bulletins often save manufacturers from spending long hours in research to overcome production problems.

Most of the committee's early activity was in the field of substitutions for critical materials. A majority of the directives and bulletins which have been issued to date concern substitutions. More recently, however, as manpower grew to be more critical than materials, the committee's trend has been toward manufacturing improvements which will save time, machines, manpower, facilities and materials, yet boost production. Work on substitutions, however, has not been discontinued.

Suggestions Welcomed

The committee welcomes suggestions of this nature from all quarters, but is exerting a special effort to promote them from the aircraft manufacturers and the processing industries. When a suggestion is made which appears feasible and which would, if accepted, yield sufficient gains to make its investigation worthwhile, the committee determines the agency which can best develop and test the idea. That agency is assigned to perform a stipulated job on the suggestion and report back. The report is studied and argued out by committee members keeping in mind not only the needs of their own agencies but also the common goal of increased aircraft production. Possibly further tests and studies are ordered. Finally the suggestion, if tests have shown it worthwhile, is accepted or rejected, and the suggestion is formalized by issuance of a bulletin or a directive. The mechanics of the committee's operations are as simple as that—but the research and development are another matter.

Sometimes the testing or development job which must be done before a suggestion can be adopted is too great for one agency. When the National Emergency steels were being considered for aircraft work, for instance, no one company was in a position to do the whole testing job as quickly as it needed to be done. So the job was parceled out among various companies and the Services.

When a project is adopted for consideration, it is assigned to one of the member agencies for development. That agency performs the required investigation by itself or enlists the aid of an outside agency, possibly a manufacturer, or WPB's Office of Production Research and Development, the National Research Council, the Society of Automotive Engineers and other like organizations. The Pressed Steel Institute, for example, is experimenting on a number of applications of stampings for forgings. Whoever does the work, responsibility rests with one of the member agencies until the project has been reported back to the committee and finally accepted or rejected.

Sometimes a new substitution or a new manufacturing method is brought to the committee with development work already done. Or perhaps it is a simple change which requires little work. In such cases, the committee, having assured itself of the value of the suggestion, helps obtain clearance for it in considerably less time than is normally consumed by a manufacturer chasing through the halls of the Navy, Munitions and Pentagon Buildings in Washington.

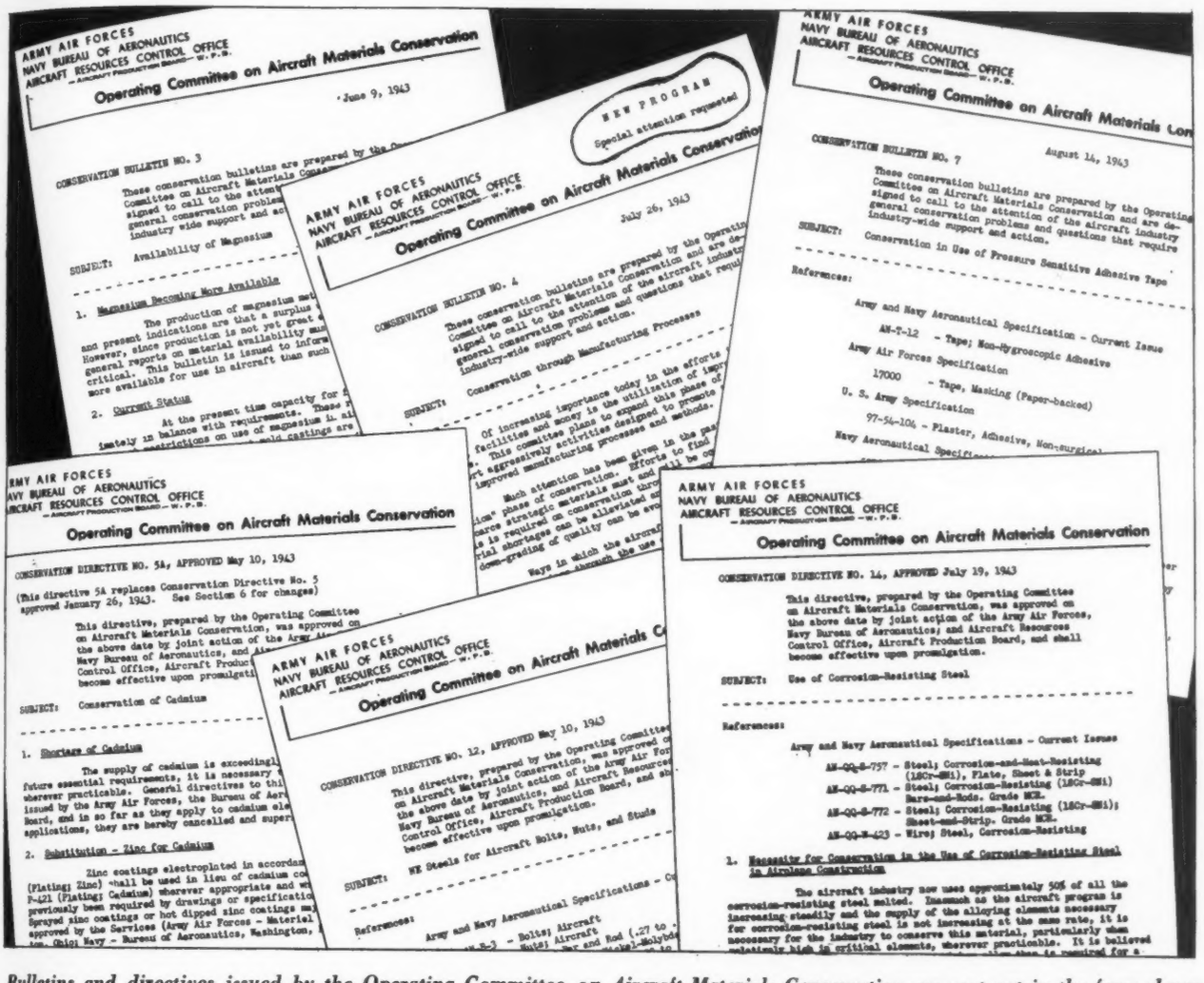
The committee is making every effort to inject the viewpoint of production engineers and material supply experts into the design and redesign of aircraft parts, the object being to insure items which are not only technologically correct but which are best adapted to mass production and which fit best into the current material picture.

Directives issued thus far cover widely-varied subjects. The latest restricts the use of certain types of corrosion-resisting steel to parts of the exhaust system which come in contact with exhaust gases and which are exposed to high temperatures; to supercharger systems; to vital engine or engine accessory parts which are exposed to temperatures over 800 deg. F., during fabrication or service and which are subject during service to severely corrosive conditions apt to induce fatigue failure; to hinges and hinge pins and to welding rod and electrodes used in welding the above material. The directive was issued because the supply of anti-corrosion alloying elements is not increasing at the same pace as demands for corrosion-resistant steel.

Appeals Can Be Made

Manufacturers who feel that the directive's limitations will adversely affect performance or reliability can appeal to the contracting agency. As materials become more available the committee relaxes the restrictions. Other directives:

Authorize use of reclaimed zinc chromate primer; require use of certain NE steels for aircraft bolts, nuts and studs; require periodic reports on industry conservation measures; substitute reclaimed and synthetic for crude rubber for aircraft storage bat-


ARMY AIR FORCES
NAVY BUREAU OF AERONAUTICS
AIRCRAFT RESOURCES CONTROL OFFICE
Operating Committee on Aircraft Materials Conservation
June 9, 1943
CONSERVATION BULLETIN NO. 3
SUBJECT: Availability of Magnesium
1. Magnesium Becoming More Available
2. Current Status
NEW PROGRAM
Special attention requested
July 26, 1943
CONSERVATION BULLETIN NO. 4
Conservation through Manufacturing Processes
August 14, 1943
CONSERVATION BULLETIN NO. 7
Conservation in Use of Pressure Sensitive Adhesive Tape
References:
Army and Navy Aeronautical Specification - Current Issue
AN-T-12 - Tape; Non-Hygroscopic Adhesive
Army Air Forces Specification
17000 - Tape, Masking (Paper-backed)
U. S. Army Specification
97-54-104 - Plaster, Adhesive, Non-Surgical
CONSERVATION DIRECTIVE NO. 5A, APPROVED May 10, 1943
(This directive 5A replaces Conservation Directive No. 5 approved January 26, 1943. See Section 6 for changes)
SUBJECT: Conservation of Cadmium
1. Shortage of Cadmium
2. Substitution - Zinc for Cadmium
CONSERVATION DIRECTIVE NO. 12, APPROVED May 10, 1943
SUBJECT: NE Steels for Aircraft Bolts, Nuts, and Studs
CONSERVATION DIRECTIVE NO. 14, APPROVED July 19, 1943
This directive, prepared by the Operating Committee on Aircraft Materials Conservation, was approved on the above date by joint action of the Army Air Forces, Navy Bureau of Aeronautics; and Aircraft Resources Control Office, Aircraft Production Board, and shall become effective upon promulgation.
SUBJECT: Use of Corrosion-Resisting Steel
References:
Army and Navy Aeronautical Specifications - Current Issues
AN-QQ-S-757 - Steel; Corrosion-and-Heat-Resisting (18Cr-8Ni), Plate, Sheet & Strip
AN-QQ-S-771 - Steel; Corrosion-Resisting (18Cr-8Ni) Bars-and-Rods. Grade MCR.
AN-QQ-S-772 - Steel; Corrosion-Resisting (18Cr-8Ni); Sheet-and-Strip. Grade MCR.
AN-QQ-W-423 - Wire; Steel, Corrosion-Resisting
1. Necessity for Conservation in the Use of Corrosion-Resisting Steel in Airplane Construction

Bulletins and directives issued by the Operating Committee on Aircraft Materials Conservation are sent out in the form shown above. The three forms on top are bulletins prepared by the Committee to call the aircraft industry's attention to general conservation problems and questions that require industry-wide support and action. The lower forms are directives which become the "law of the land" and warrant strict compliance by the aircraft industry. These forms culminate intensive study and research.

tery menoblocs; require the melting of high-grade zinc forming and stamping dies; restrict aircraft plywood and veneer to one Army-Navy Aeronautical specification; establish standards for application of aluminum alloy products which allow increased production of extrusions and other shapes; require substitution of zinc for cadmium plating in certain non-critical applications; require certain conservation measures in the use of beryllium copper; require the use of NE steels wherever possible; require certain standardization of swaged cable terminals to increase production of these items, and require certain conservation measures and stipulate substitutes of methyl methacrylate.

Bulletins issued thus far deal with the use of alloy steels in aircraft, availability of phenolic resins for use in aircraft components, availability of magnesium, conservation through manufacturing processes, conservation of cadmium, conservation in the use of pressure-sensitive tape and similar material problems.

New Materials Promoted

Through these directives and bulletins the committee promotes and approves the new materials, such as NE steels; it aids in rubber conservation and in the conversion from crude to the new synthetics; it helps solve problems arising from shortage of manufacturing facilities; by requiring use of certain standard materials; it promotes most efficient use of available materials and facilities; it directs that less critical materials be substituted for critical items; it aids programs to reclaim used and obsolete materials; it steps up production and conserves materials by promoting improved manufacturing methods; and it furnishes reliable information on material availability.

All the committee's work represents cooperative effort on the part of all the divisions of the Army Air Forces, the Bureau of Aeronautics and the WPB. For example, the AAF Materials Laboratory at Wright Field, the Engineering Division of the Bureau of Aeronautics and the WPB Steel Division may work jointly on a project which is released to the aircraft industry as a joint statement by the Operating Committee. Other projects may be developed by the Inspection divisions, the Power Plant sections—in fact, every branch of the Army Air Forces, Navy Bureau of Aeronautics, and War Production Board may work with the committee on common problems. The committee acts as the coordinating and distributing agency for all Government agencies and with the field offices of the Services following through with the individual aircraft contractors a truly united front is presented on all conservation questions.

Electronic Controls For Industrial Machines

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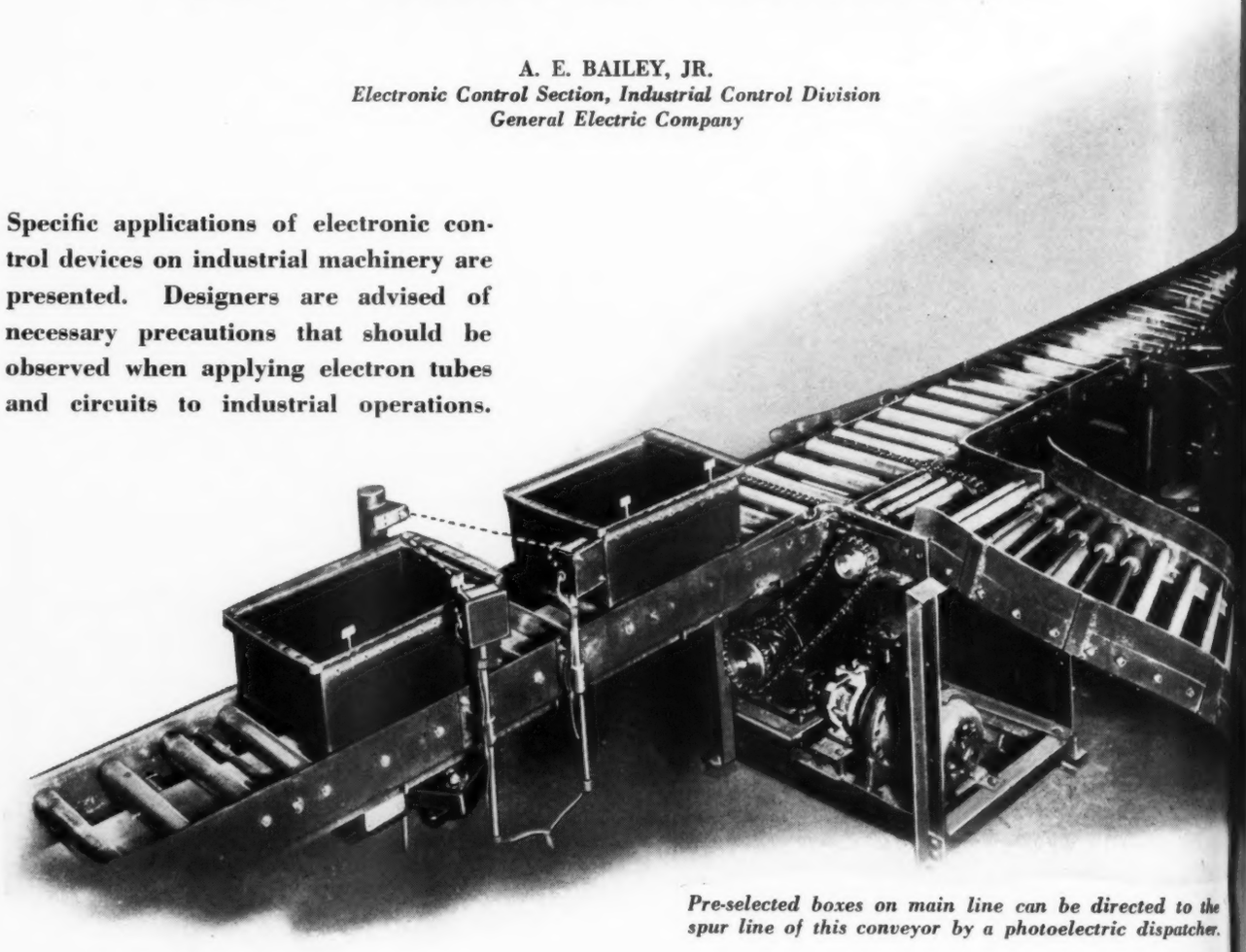
General Electric Company

Specific applications of electronic control devices on industrial machinery are presented. Designers are advised of necessary precautions that should be observed when applying electron tubes and circuits to industrial operations.



Pre-selected boxes on main line can be directed to the spur line of this conveyor by a photoelectric dispatcher.

ELECTRONIC controls have contributed immeasurably to improving the quality of products and reducing costs, allowing higher operating speeds, and permitting amplification of small amounts of electrical or mechanical quantities.

Some industrial applications of electronic control to machines follow: Thyratron resistance welding control; automatic photoelectric web-register control—cut-off, perforating, or multicolor printing; automatic photoelectric side-register control—slotting, perforating and edge-alignment; automatic electronic timing of thermoplastic molding machines; photoelectric protection against damage to punch press dies when punched piece fails to leave ram; variable-speed control of motors.

Another important application is automatic photoelectric registering and detection in machines designed for special operations including the following: Register of toothpaste tube on filling machine for location of crimp; detecting absence of milk bottle caps on bottling machine; automatic operation of sheet-catcher tables in rolling mills; automatic weighing processes; control of pre-selective conveyor-dispatching systems; automatic stopping of conveyor when jams occur; paper-break detector on printing presses.

Accurate control is essential for making uniform welds by the resistance-welding process. Welding machines have a throat through which material to be welded must pass. Since the throat becomes a part of the secondary circuit of the welding transformer, the circuit is highly reactive.

The value of current flowing in the secondary circuit immediately after the primary circuit is closed depends largely on the instantaneous value of voltage at the time of the circuit closing. If the circuit is closed at a point on the line voltage wave corresponding to zero current, the current during the first half cycle will be about the same as that of succeeding cycles. To repeat this operation for each weld requires a control system definitely related to and actuated by the pulsating voltage of the a.c. system.

If, however, the circuit is not closed at a point on the voltage wave corresponding to zero current, nor synchronized with the pulsating voltage of the power supply, the secondary current during the first half cycle reaches a higher peak value. Values of current diminish gradually for suc-

ceeding cycles. As the heat in the weld is proportional to current squared, a weld made under these conditions will receive a vastly different amount of heat for each difference in the starting time of the first half cycle of the weld. Obviously under such conditions, accurate control of the welding current is impossible and results in non-uniform welds.

Other functions of the welding machine can be controlled electronically. For example, sequence timers are available to control the length-of-time interval between application of pressure to the work and application of power (squeeze period).

If the weld is of the type which consists of a series of pulses of welding current, with intervening cooling periods between welds, the squeeze period timer will at the expiration of its timing cycle energize a weld period timer. This timer will then determine the over-all time for the series of pulsation welding. At the expiration of this period, a third timer is initiated to hold the electrodes closed long enough to allow the weld to congeal under pressure. If the welding cycle is to be repeated automatically, the hold period timer will initiate an "off" period timer which will time the interval during which the pressure mechanism is not energized before repeating the welding cycle.

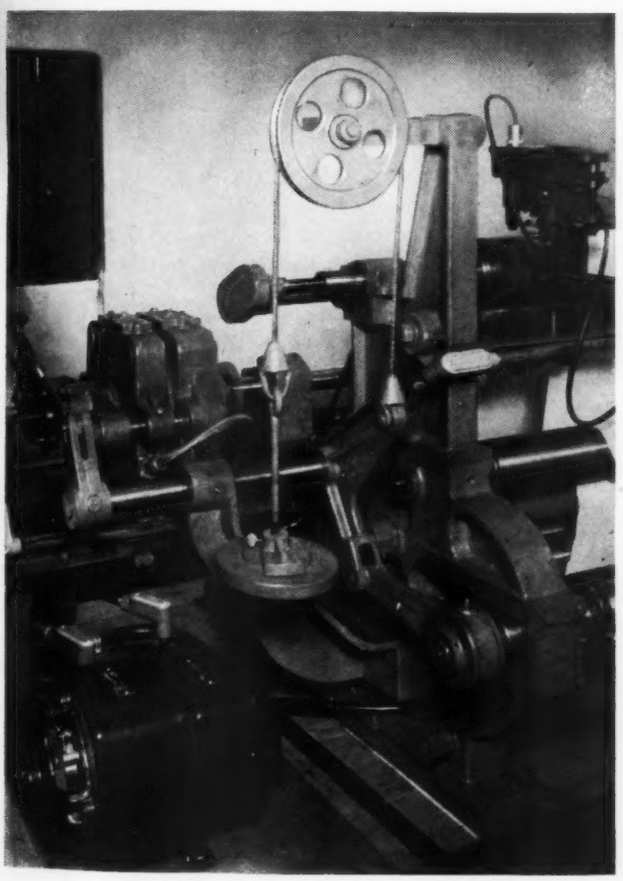
Printing Applications

The package and bag-making industry now prefers use of a unit printed design on the wrapper or container rather than the so-called over-all design. As permissible printing speeds are greater than those in the bag-making or packaging operations, it is more economical to print on a continuous web of paper. Therefore, one printing machine can serve several bag-making machines. Where the printed roll is used in a bag or package processing machine, there arises the problem of keeping the printed design in register with the cutter.

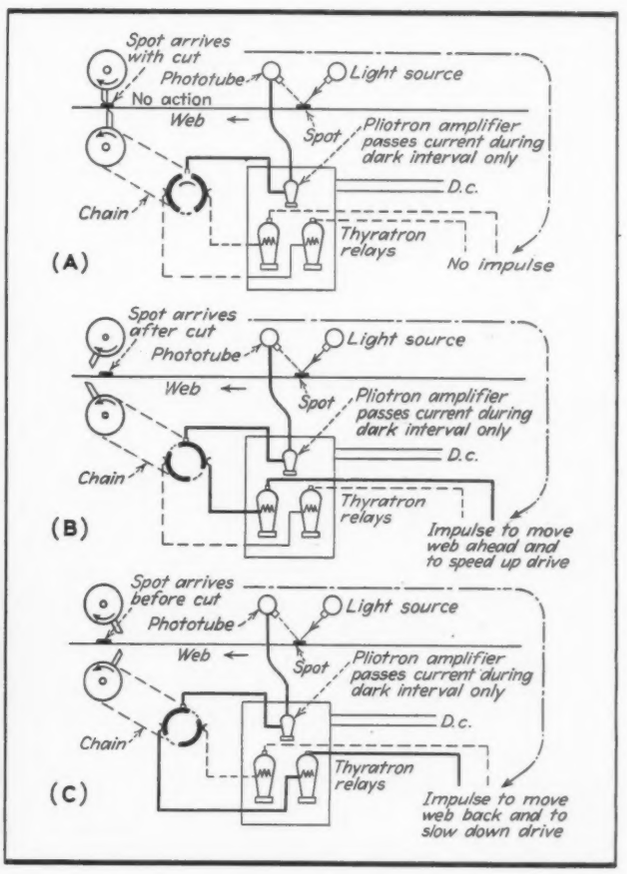
Draw roll slippage, stretch, or shrinkage of a web of material under varying moisture conditions and tensions can cause errors of 0.1 of 1 percent. As these errors are cumulative the location of the cut will creep approximately ⅛ in. for each 10 units passed through the machine, with each unit measuring one foot in length.

It is necessary in order to correct for this condition that a packaging or bag-tubing machine equipped for handling a printed web have some provision for varying the angular position between the draw roll and the rotating knife which cuts the paper. Similar problems arise on printing press webs where it is necessary to print an overlay color in register with a preprinted color, or the objective might be to control the location of perforations between printed forms, such as on postage stamps. The problem is essentially the same, and while the design of the correcting apparatus may differ and requirements and speeds vary greatly, the fundamentals are alike.

In a bag-making or packaging machine, the introduction of a differential gear between the gear-train driving the cutter and the draw rolls makes possible a correction by advancing or retarding the control elements of the differential. This is known as space correction. To avoid space correction at frequent intervals and to maintain a closer relationship between the cutter and draw rolls, a



Photoelectric paper side-register control equipment on winder and slitter. Side-register control is also necessary to obtain accurate alignment when web material is to be perforated.



Conditions in the operation of a register control which cause (A) no control, (B) speed-up of the web and drive, and (C) slowing down of web and drive.

permanent correction in the speed relationship between these rolls can be made from the same impulse.

Photoelectric control equipment has been used for permanent correction. Many of these devices are in successful operation at present. Usually, a small register mark on the web and the main design are printed simultaneously. The register mark is printed generally near the edge of the web so it will be the only printing passed beneath the phototube's scanning point. The mark is usually concealed in the fold of the finished product.

Passage of the register mark beneath the phototube initiates an electrical impulse which can be amplified and used to determine the exact instant of the mark's passage.

A two-circuit timing or selector switch is driven from the cutter roll. If the impulse from the phototube arrives at the switch at the same instant that both circuits are open, no action results. However, if the mark arrives before or after its proper time, the impulse is impressed upon the grid circuit of one of the two thyratron tubes. When it is impossible to provide a clear track for the register marks the switch renders the circuit temporarily inoperative while printing passes the phototube between register marks.

The amplified phototube signal voltages impressed on the grids of thyratrons cause them to permit the flow of current between their anode and cathode. Magnitude of these currents makes possible direct operation of magnetic relays. The relays, in turn, through their circuits control motors or solenoids for advancing or retarding the cut-off position and for making the proper speed adjustment.

Electronic Timer

Many processes require some means of operating a specific device, such as a valve, motor or heater, for a definite period of time. When the required timing period is relatively short and repeated frequently, the wear of mechanical parts becomes a serious problem.

Elimination of moving parts is made possible by a device combining an electron tube, capacitors, resistors, a small magnetic relay, and a transformer. The device, commonly known as a vacuum tube time-delay relay, has only one moving part, which is the armature of the electro-magnetic relay actuated by the electron tube. The length of the time delay can be adjusted by a potentiometer.

Either singly or in combination, these timers will regulate many of the functions of processing machines. One application is a combination of three timers, mounted on an automatic injection molding machine for thermoplastics. The timers sequentially time the filling, heating and curing operations through which the molded parts must pass.

Registration of Phototubes

Typical of the many automatic operations on machines which are controlled electronically is the machine for filling and crimping toothpaste tubes. As four toothpaste tubes must be filled and crimped simultaneously, four photoelectric relays are used. Phototubes for the relays are located behind a screen at a point where the toothpaste tubes are rotated for filling and crimping.

Each toothpaste tube has a printed mark in register with the main printed design. As the mark has a different reflecting power than the bright tube, it causes the phototube to function when the mark passes before it. The tube is then stopped instantly and held in this position until it has been crimped, the crimp concealing the mark.

Speed Control of D. C. Motors

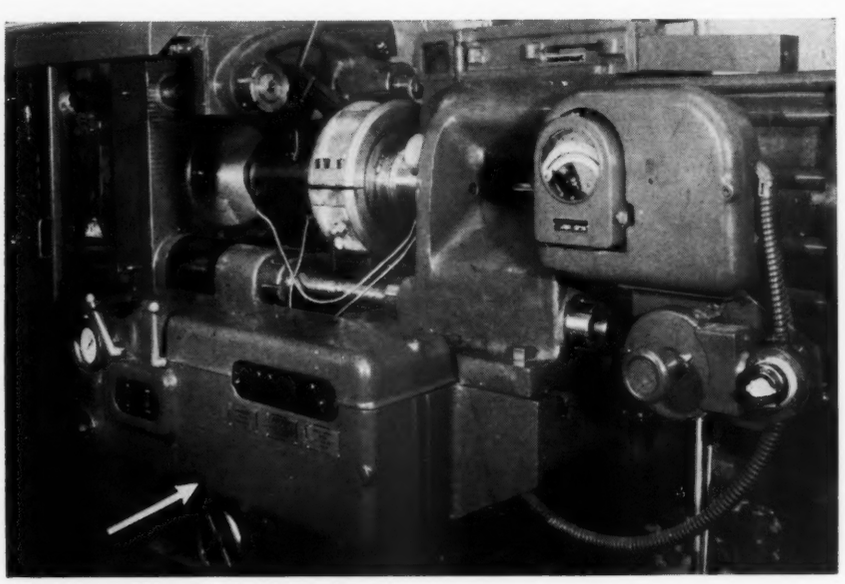
The thyratron, a grid-controlled gas-filled rectifying tube is ideally suited for accurate and stepless speed control of d.c. motors operating from an a.c. supply. A small amount of electrical energy can control the speed of a motor capable of delivering several horsepower. The speed control station is merely a small potentiometer mounted in the same conventional pushbutton station that mounts the "start, stop, jog and reverse" buttons.

Applications include grinders, milling machines, tool room lathes, thread millers, testing machines, and many other standard or special equipment. Motors can be preset for operation speed. Close regulation of the armature voltage is provided and compensation for IR drop is automatic.

Design Precautions

For best operation, machines employing electronic devices should be designed with the following precautions in mind: Good ventilation; arrange tubes and control equipment for easy servicing and adjustment; protect panels and tubes from vibration; specify minimum length of leads and adequate grounds, and designate that flexible leads to panel are to be insulated against machine shock and vibration; keep installation free from dirt and moisture; place tubes so they will not contact metallic objects or be subject to drops or spray of liquids; avoid excessive extraneous light on phototube directly or by reflection; refrain from locating electronic panels or tubes in regions of high ambient temperature, which shortens the life of tubes and parts.

Design engineers are fully cognizant of potential applications of electronics in the industrial fields of tomorrow. Electron tubes and circuits represent an important factor in the design and production of better and more efficient products.



Injection molding machine for thermoplastics. Arrow points to a panel which contains three electron tube time-delay relays.

WARTIME DESIGNS

Formed and Composite Parts Simplify Binocular Mount

RIGID MECHANISMS consisting of formed sheet steel and parts built-up by welding or brazing are being designed with as close dimensional tolerances and rigidity as are possible by any other method of fabrication. Lewyt Corporation, Brooklyn, N. Y., cites the following advantages of the fabricating technique: Cuts cost in half; reduces production time; simplifies machining operations; conserves materials; affords equivalent service qualities. These advantages were realized in the redesign for the Sperry Gyroscope Company of the binocular mount on the unit employed in automatically aiming the Army's 60-in. searchlight. Although formerly constructed of aluminum castings, mount weight alone was reduced from about 32 to 24 pounds.

Design is adaptable to either small or large scale production. Simplification in design allowed use of simple jigs and fixtures with which semi-skilled workers can produce the extremely close dimensional tolerances required on many of the parts. Hand fitting was reduced to a minimum and considerable machining was eliminated. Material flaws and workmen's errors can cause only minor losses.

Three weeks were required to redesign and deliver a handmade sample control unit, of which the binocular mount with its nearly 75 parts is a member. Major dimensions are unchanged. Many parts and assemblies are interchangeable with those on the replaced unit.

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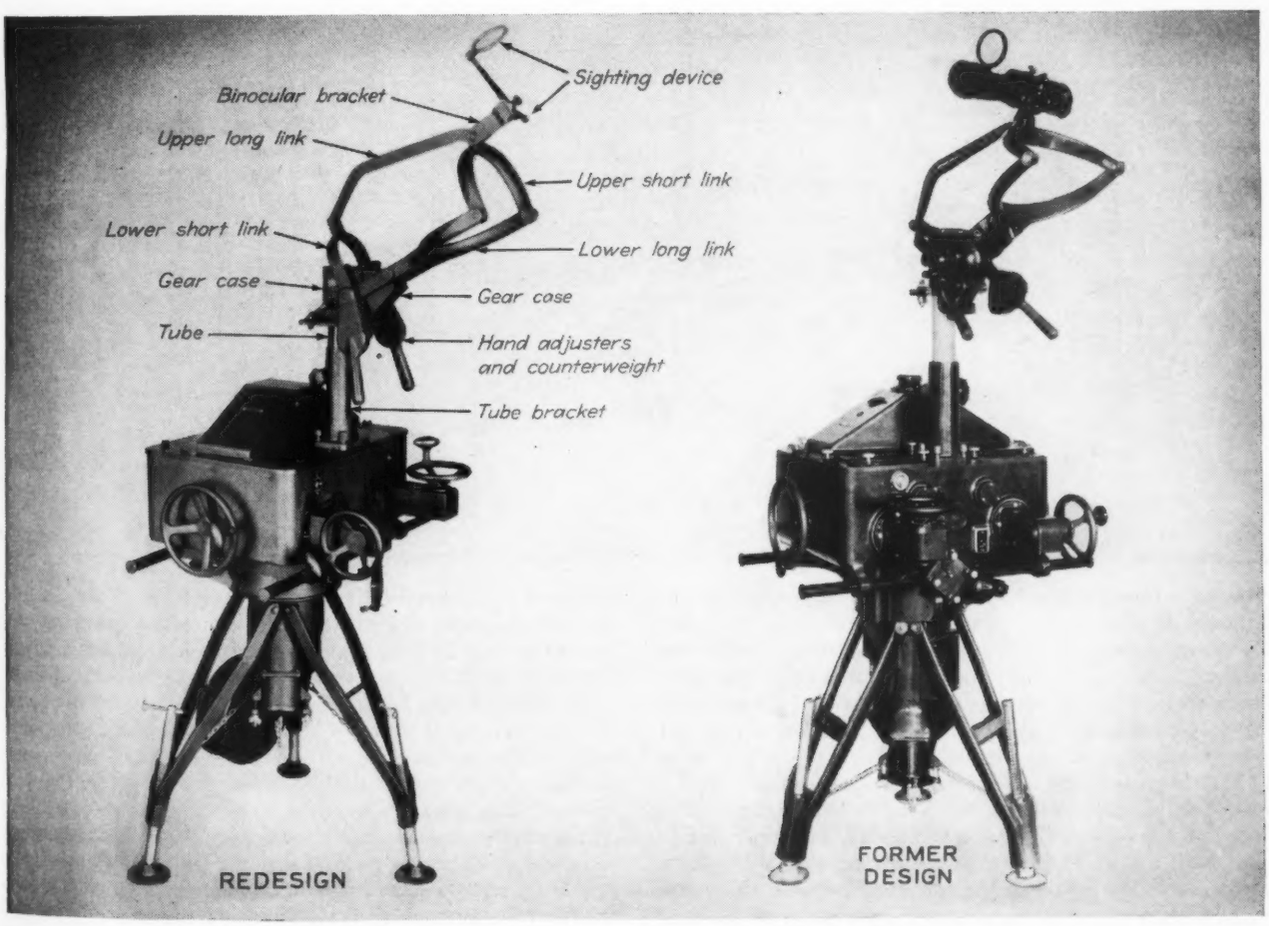
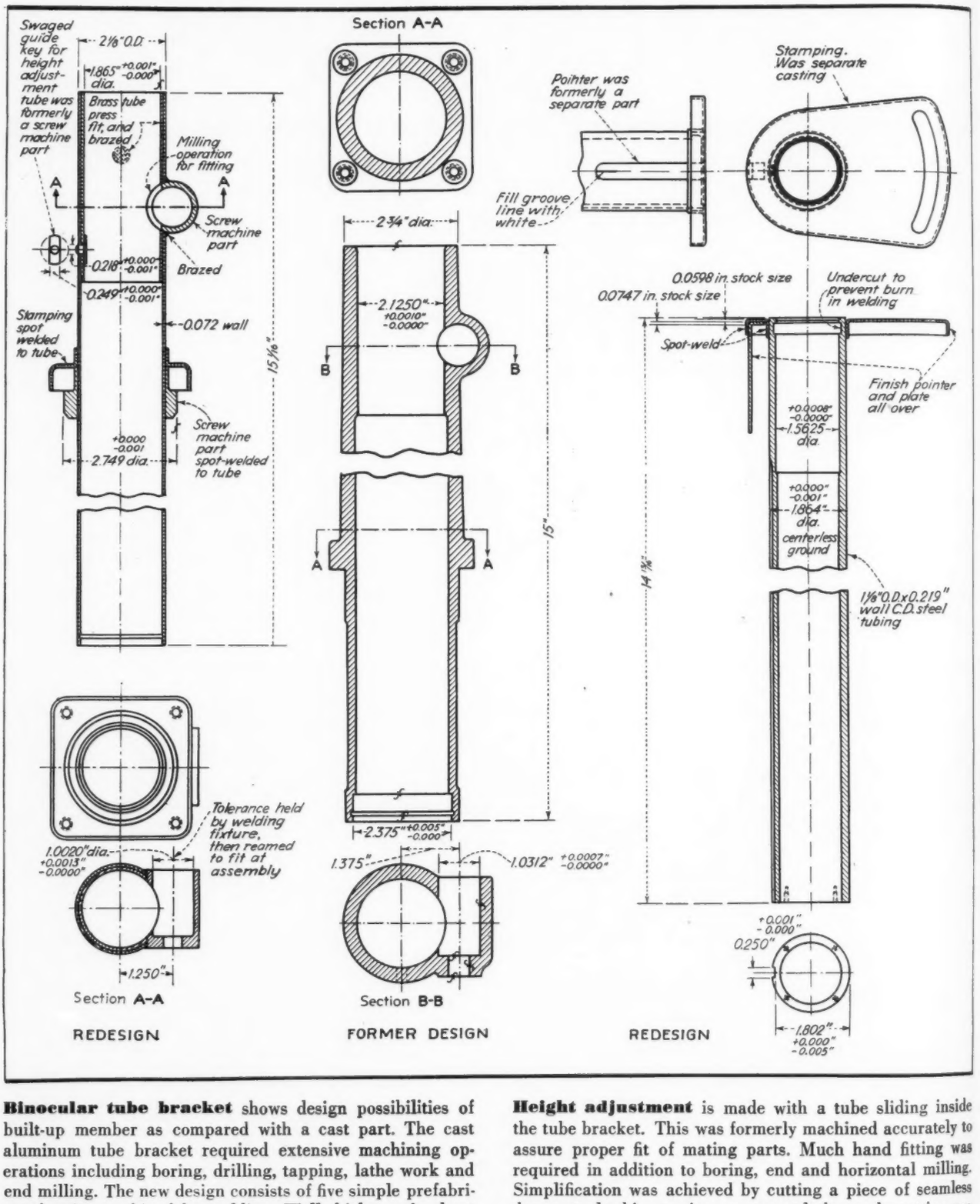
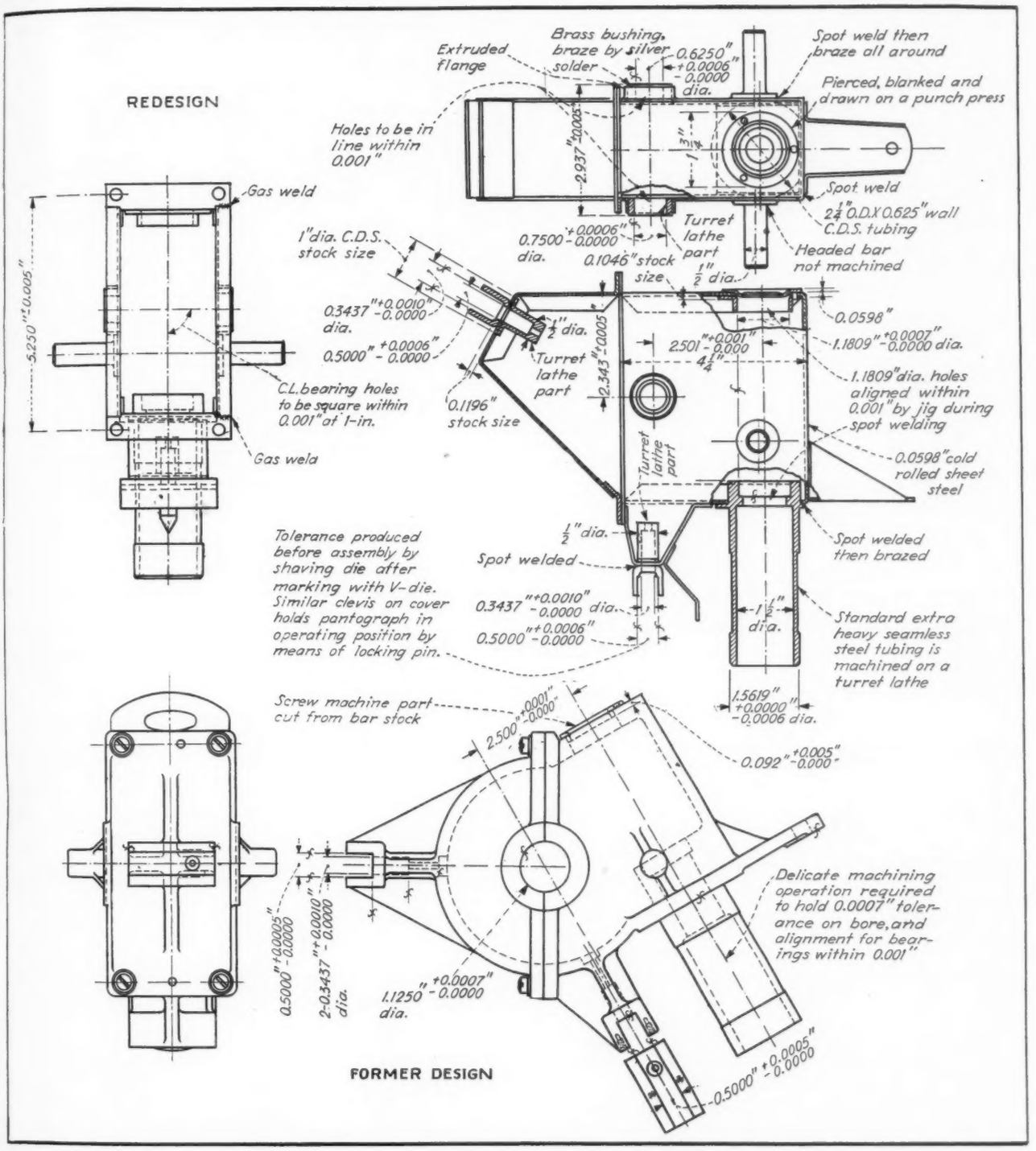


Binocular Mount (continued)



Binocular tube bracket shows design possibilities of built-up member as compared with a cast part. The cast aluminum tube bracket required extensive machining operations including boring, drilling, tapping, lathe work and end milling. The new design consists of five simple prefabricated units combined by welding. Wall thickness is about one-third that of the cast aluminum bracket but the same rigidity is preserved. Finished cost is less than half that for the cast bracket. Close dimensional tolerances are produced at least as readily as on the casting. Even as simple and small a part as the guide key for holding the height-adjusting tube aligned in the tube bracket was simplified by changing it from screw machine to swaged part.

Height adjustment is made with a tube sliding inside the tube bracket. This was formerly machined accurately to assure proper fit of mating parts. Much hand fitting was required in addition to boring, end and horizontal milling. Simplification was achieved by cutting a piece of seamless drawn steel tubing to size on a turret lathe, undercutting one end, drilling and tapping on the other end, and centerless grinding to the required tolerance on the diameter. Pointer plate and pointer, formerly separate parts, one of which was a casting, are now made a part of the tube. Production cost was cut to one-eighth of that for the aluminum parts, which are not shown. New design is considerably simplified. Hand fitting and many machining operations are avoided.


REDESIGN
Extruded flange
Brass bushing, braze by silver solder
0.6250" +0.0006" -0.0000" dia.
Spot weld then braze all around
Pierced, blanked and drawn on a punch press
Holes to be in line within 0.001"
2.937" ±0.005"
1 1/2"
Spot weld
2 1/4" O.D. X 0.625" wall C.D.S. tubing
Gas weld
1"dia. C.D.S. stock size
0.7500" +0.0006" -0.0000" dia.
0.1046" stock size
Turret lathe part
1/2" dia.
Headed bar not machined
5.250" ±0.005"
0.3437" +0.0010" -0.0000" dia.
0.5000" +0.0006" -0.0000"
1/2" dia.
0.0598"
2.501" +0.001" -0.000"
4 1/4"
1.1809" +0.0007" -0.0000 dia.
Turret lathe part
2.343" ±0.005"
C.L. bearing holes to be square within 0.001" at 1-in.
0.1196" stock size
1.1809" dia. holes aligned within 0.001" by jig during spot welding
Gas weld
Turret lathe part
0.0598" cold rolled sheet steel
1/2" dia.
Spot welded
Spot welded then brazed
Tolerance produced before assembly by shaving die after marking with V-die. Similar clevis on cover holds pantograph in operating position by means of locking pin.
0.3437" +0.0010" -0.0000" dia.
0.5000" +0.0006" -0.0000"
1 1/2" dia.
Standard extra heavy seamless steel tubing is machined on a turret lathe
Screw machine part cut from bar stock
2.500" +0.001" -0.000"
1.5619" +0.0000" -0.0006" dia.
0.092" +0.005" -0.000"
Delicate machining operation required to hold 0.0007" tolerance on bore, and alignment for bearings within 0.001"
0.5000" +0.0005" -0.0000"
2-0.3437" +0.0010" -0.0000" dia.
1.1250" +0.0007" -0.0000" dia.
0.5000" +0.0005" -0.0000"
FORMER DESIGN

New gear case required more work on design than any other part of the binocular mount. Although the number of component parts was stepped up from 2 to 12, the resulting simplicity in production reduced the finished cost to almost a third of that for the cast aluminum case. Gear case and cover proper are formed on power press brakes. Assembly of members and bracket attachments is accomplished by spot welding and brazing with the aid of jigs and fixtures to hold close dimensional tolerances.

Formerly the whole casting had to be handled for milling machine operations. The new gear case is at least as rigid and resistant to shock as the original casting.

A feature of the design is the bushing for the vertical drive-shaft bearing. Formerly an integral part of the cast aluminum case, the bushing required extremely careful machining to meet tolerances on the diameter and in alignment with another bearing pressed into the cast gear case. This difficulty was avoided in the redesign by aligning an accurately-sized stamped bushing with a jig during spot welding. These bushings are made at the rate of 1½ min. per piece by a semi-skilled worker.

The bearing retainer in the top of the gear case was changed from a screw machine part to punch press part and produced at a tenth the former labor cost. This change is typical of several made on the binocular mount.

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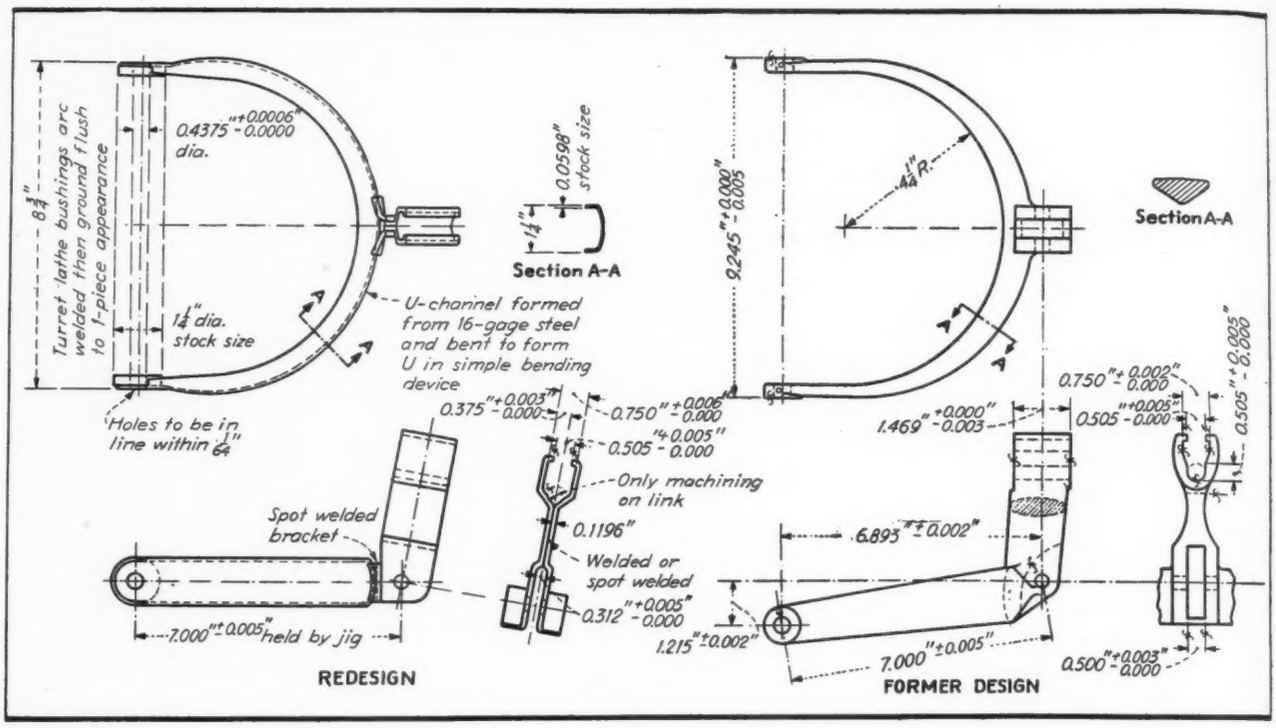
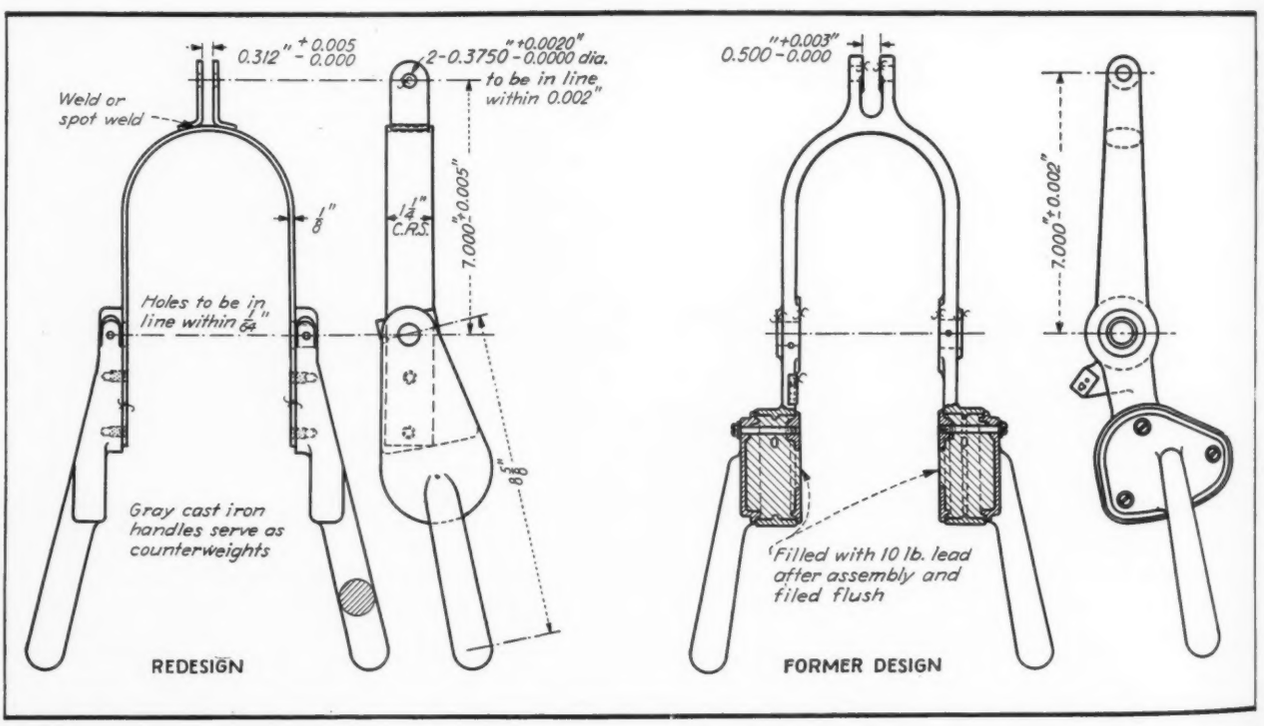
Binocular Mount (continued)



Short upper link of the pantograph mount now consists of four parts welded into a unit. The U-shaped yoke proved simple to form after a little shop experimentation. Forming is done with a simple home-made bending tool. The 16-gage steel in this shape has adequate strength and stiffness for its purpose A similar yoke is used in the adjoining lower link, the details of which are not shown in the illustration above.

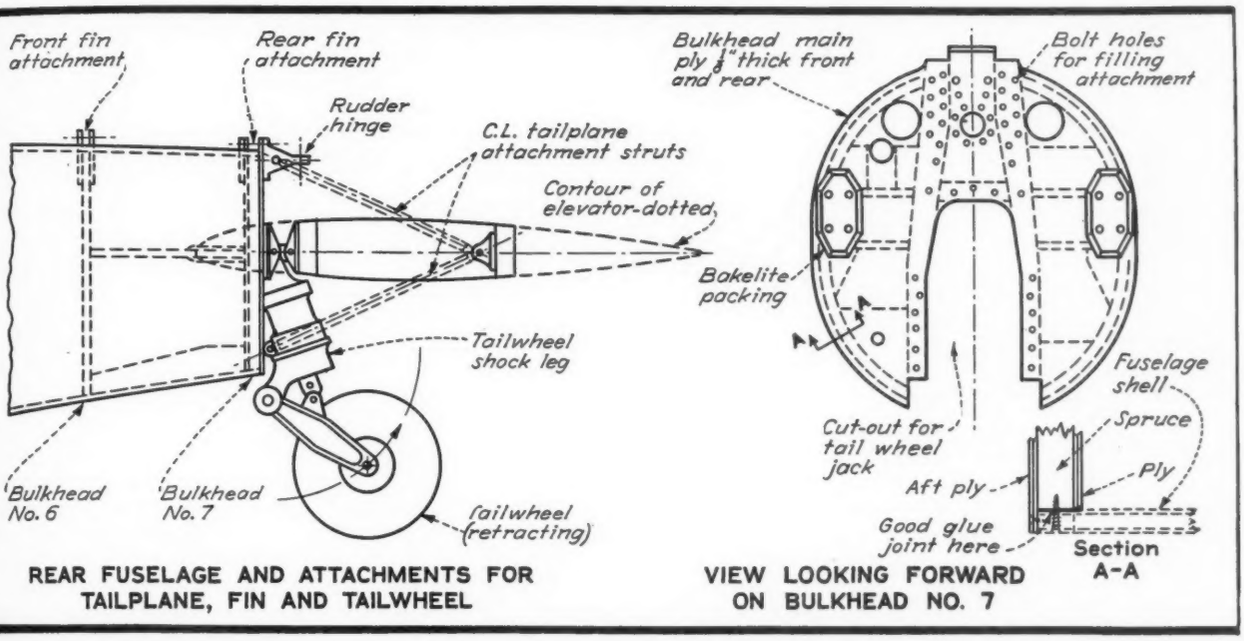


Short lower link was formerly an intricately-shaped aluminum casting requiring much machining. An equivalent part is produced by substituting cold-rolled strip steel and welding three members together in a fixture.

A tie bar of accurate length between bearing centers serves as the long upper link. The link is made of 1 by $\frac{3}{16}$-in. bar stock bent to shape after drilling holes for bushings at each end so that the distance between centers can be held by a jig to within 0.005 in. Flat surfaces of these bushings are held in line within $\frac{1}{64}$-in.

Additional Design Features of Mosquito Bomber

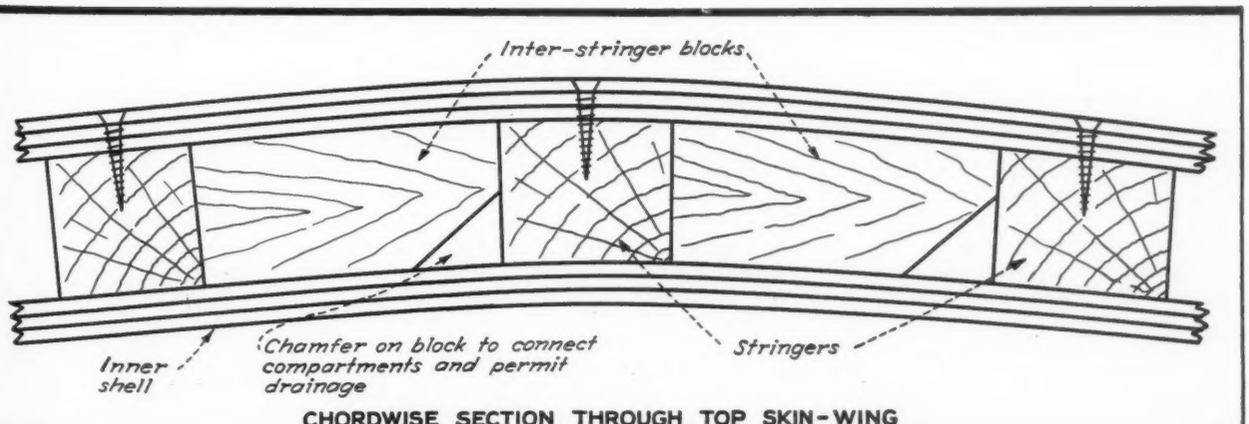
THE MAIN CONSTRUCTIONAL DETAILS of the de Havilland Mosquito were described and illustrated on pages 683-688 in the November issue of PRODUCT ENGINEERING. The drawings and descriptions on this and the following pages supplement that article with data on tailplane and fin attachment, weatherproofing, repair, structural weights and types of wood used. Balsa wood as core material in the fuselage is discussed.



REAR FUSELAGE AND ATTACHMENTS FOR TAILPLANE, FIN AND TAILWHEEL

VIEW LOOKING FORWARD ON BULKHEAD NO. 7

Tail Plane and Fin Attachment. Some designers hesitate to use the monocoque-type fuselage because of complications which can arise in tailplane and fin attachment. In the Mosquito design, the shell is cut off abruptly at Bulkhead No. 7, (see Fig. 7 PRODUCT ENGINEERING, Nov. 1943, page 687) and the tail plane load and part of the fin load is fed directly to this bulkhead by means of tubular members and metal fittings. The bulkhead then spreads these concentrated loads into the shell through glue shear areas. Bulkhead No. 7 with its bearing blocks and internal members for spreading the loads is shown at right. At left is shown the details of connection at bulkheads Nos. 6 and 7. Bulkhead No. 6 takes front load from the fin as shown on drawing at left.



CHORDWISE SECTION THROUGH TOP SKIN-WING

Weatherproofing. When an airplane is constructed in wood, weatherproofing and protective treatments are of utmost importance. For operational aircraft this problem is increased because of the lack of hangars and the practice of "dispersing" aircraft on the ground to reduce losses from enemy action. The first working rule is to provide an ample number of drain and ventilation holes at the lowest corner of closed spaces. For spars, ribs and bulkheads a ⅛ in. dia. hole through the ply is sufficient when the hole does not lead to the outside

Mosquito Bomber (Continued)

air. Where two compartments are separated by a solid non-structural block, the compartments should be placed in communication by running a chamfer on one corner of the block or by drilling a ¼ in. or ⅜ in. hole through the block. This is done in the wing top skin as shown in the illustration on the previous page.

When large areas of plywood are glued down, "escape holes" must be provided to prevent the wet glue from becoming trapped and soaking the members. In addition, these holes prevent the formation of air bubbles and excessively thick glue lines. These escape holes can be about 1/16 in. dia. and spaced 4 to 6 in. apart, depending on the shape and size of the panel being glued.

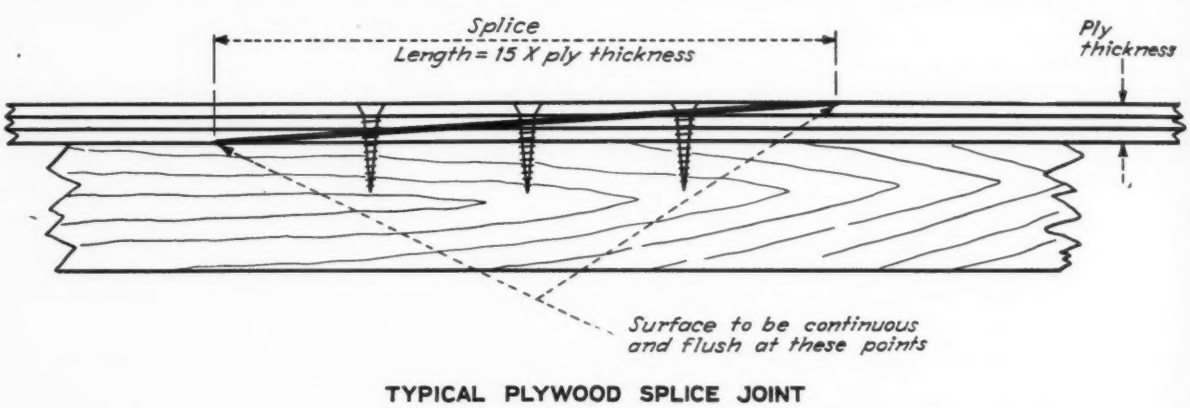
If drain and ventilation holes communicate with the outside air, holes should be larger and the hole edges themselves must be protected from moisture. An ordinary sailmaker's grommet is used for draining wing, tail and flap compartments. The hole through the ply can be ¼ to ½ in. dia. and the grommet dipped in chromate before pressing home. This gives an efficient, flush drainage point.

Great care must be taken with exposed end grain. If any balsa wood end grain is exposed, it should be coated with a bitumastic compound. A phenolic base "sealer" is best for birch and spruce end grain. Several coats should be applied until a hard, continuous, impervious surface is obtained. This will prevent moisture absorption and consequent deterioration.

For the Mosquito, the best method yet found for protecting large plywood areas is simply to "encase" the component in fabric laid in red pigmented dope. This red-doped fabric is carried completely around the edges of all holes and cutouts, even where sealers have been previously applied. A cellulose filler is then sprayed over the whole fabric surface, which is quite rough when dry. If examined under a lens, the surface will be seen to have small fibers standing up, ready to act as "wicks" to pull moisture in toward the wood surface. To remove these standing fibers and at the same time give a smooth aerodynamic surface, the doped and filled fabric is wet-sanded. Two or three coats of silver dope are sprayed on and further sanded, if necessary, before applying the camouflage scheme.

Where metal fittings are bolted up to wood, plywood or Bakelite, a liberal coating of marine glue is first applied to the fitting. This marine glue prevents moisture from being drawn between the surfaces, and increases the friction between the surfaces. While this friction is never figured in the joint stressing, it is a factor of safety in reducing the bolt bearing stresses in the timber.

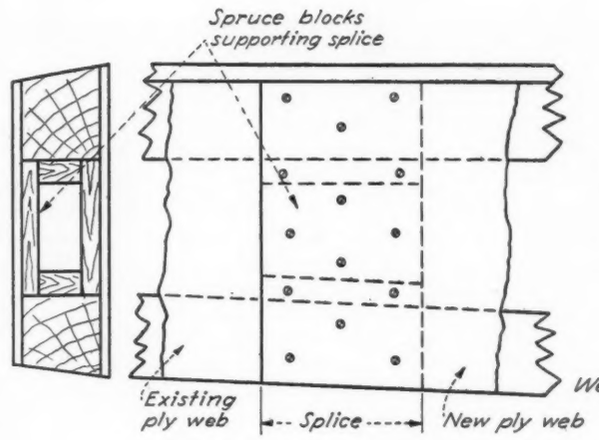
For metal to metal contact and for metal work generally, protective treatments currently used in all-metal construction are employed.



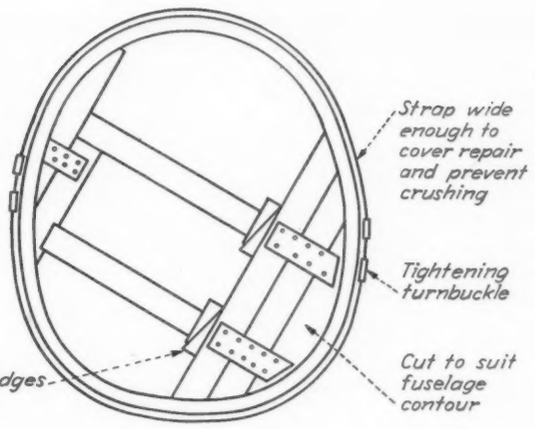
TYPICAL PLYWOOD SPLICE JOINT

Repairs. The Mosquito structure is repaired with comparative ease since only standard woodworking tools are required and the skill of a journeyman carpenter is adequate. Since wood has no definite yield point, the structure is seldom permanently "bent" or set, and fractures are clean and easy to find. For this reason it is seldom necessary to re-jig a component. By suitably supporting or jacking the structure, new pieces of timber and plywood can be spliced in position, thus renewing the component in its original form.

The standard splice or scarf joint is the basis of all Mosquito repairs. A typical splice is shown above. It is the standard de Havilland practice to use 15:1 splice slopes. All splices must have a solid backing, especially over the forward third, where the splice is coming to a feather edge. All repairs must be thought out with this backing in mind since damage to plywood usually occurs over a hollow compartment or where balsa core is present. The new piece with its scarfed edge, should be well glued and wood-screwed through the existing structure and into the solid backing material. Also shown, at right, is such a repair to a spar shear web. Spruce support members should be inserted before the splice is cut on the existing ply. This gives solid backing to the tools and insures a straight flat scarf. Damaged wood should always be replaced with wood of the same species, grain, thickness and quality. If an external patch must be used, a liberal chamfer is necessary around the edges. Efforts to make the repaired region "stronger than before" should be avoided because stress-discontinuity can be dangerous. Damage to tension members offers the most difficulty and only a trained man should be allowed to outline the method of repair. The repair should be proof against the ingress of moisture. Drain holes should be provided if the repair results in new compartments in the structure as discussed above for weatherproofing.



METHOD OF SPLICING SPAR SHEAR WEB FOR REPAIR



METHOD OF CLAMPING FUSELAGE SHELL REPAIR

THE FOLLOWING TABLE summarizes the structure weights of the components making up the "basic structure." No equipment or services are included, but metal joint fittings are considered part of the structure. The undercarriage, while not wood, has been included for comparison purposes. The empennage includes elevators, rudder, tail-cone fittings.

Component	Weight lb.	Percent Structure	Percent All Up Weight
Fuselage	615	13.7	3.5
Wing	2,220	49.5	10.0
Empennage	370	8.2	1.8
Undercarriage	1,285	28.6	6.1
Total	4,490	100.0	21.4

THE FOLLOWING IS A TABLE of the various woods employed in the Mosquito, together with the parts for which the woods are generally used:

Wood	Use
Sitka Spruce	Flanges; Booms (caps); Stringers; Reinforcings; Blocks
Douglas Fir	Compression Stringers — Booms — Blocks
Walnut	Bearing blocks
White Ash	Tension flanges
Balsa	Core filler — (non-stress carrying)
Birch Ply	Shear webs — Skins — Bearing blocks — Reinforcings
Spruce Ply	Fuselage skins

FUSELAGE SKIN STRESSES are comparatively low because of the depth available. A single thickness of ply wood results in a thin skin. Such skins are "wavy" and have a low buckling stress. Longitudinal stringers are not a satisfactory solution. In the Mosquito design, the problem was solved by dividing the ply thickness requirement in two and separating these two skins by a distance great enough to give a reasonable radius of gyration. Of course, to combat buckling successfully it is necessary to shear-connect these two "extreme ply fibers" through some medium. Here balsa was selected as the continuous supporting medium for the ply skins. It is not a primary load carrying material so that the balsa boards (about ½ in. thick) need not be spliced or glued together, and the location of the balsa joints is unimportant. The main requirements are that it be light (8 to 10 lb. per cu. ft.) and glue easily to the ply skins. Excess glue must not be picked up and held in the balsa cells. Other core materials have been suggested and tried, but so far, only balsa meets successfully all the requirements of lightness and ease of gluing.

WARTIME DESIGN NEWS

ANOTHER SECRET WEAPON:

The Army has come up with another design triumph which is paying off on the battlefield—a rifled 4.2-in. mortar the range and accuracy of which are well above those of the 81-mm. and 60-mm. smooth-bore mortars.

The credit this time goes not to the Ordnance Department but to engineers of the Chemical Warfare Service who developed the rotating band which allows the 4.2 tube to be rifled. Earlier U. S. mortars, muzzle-loaders all, were smooth-bore to allow a projectile to be dropped down the sloping tube. The trick rotating band on the 4.2 projectile allows the same type of loading, but the band expands just enough on impact with the closed breech to bite into the lands and get the benefit of longer range and increased accuracy which a rifled bore affords a projectile.

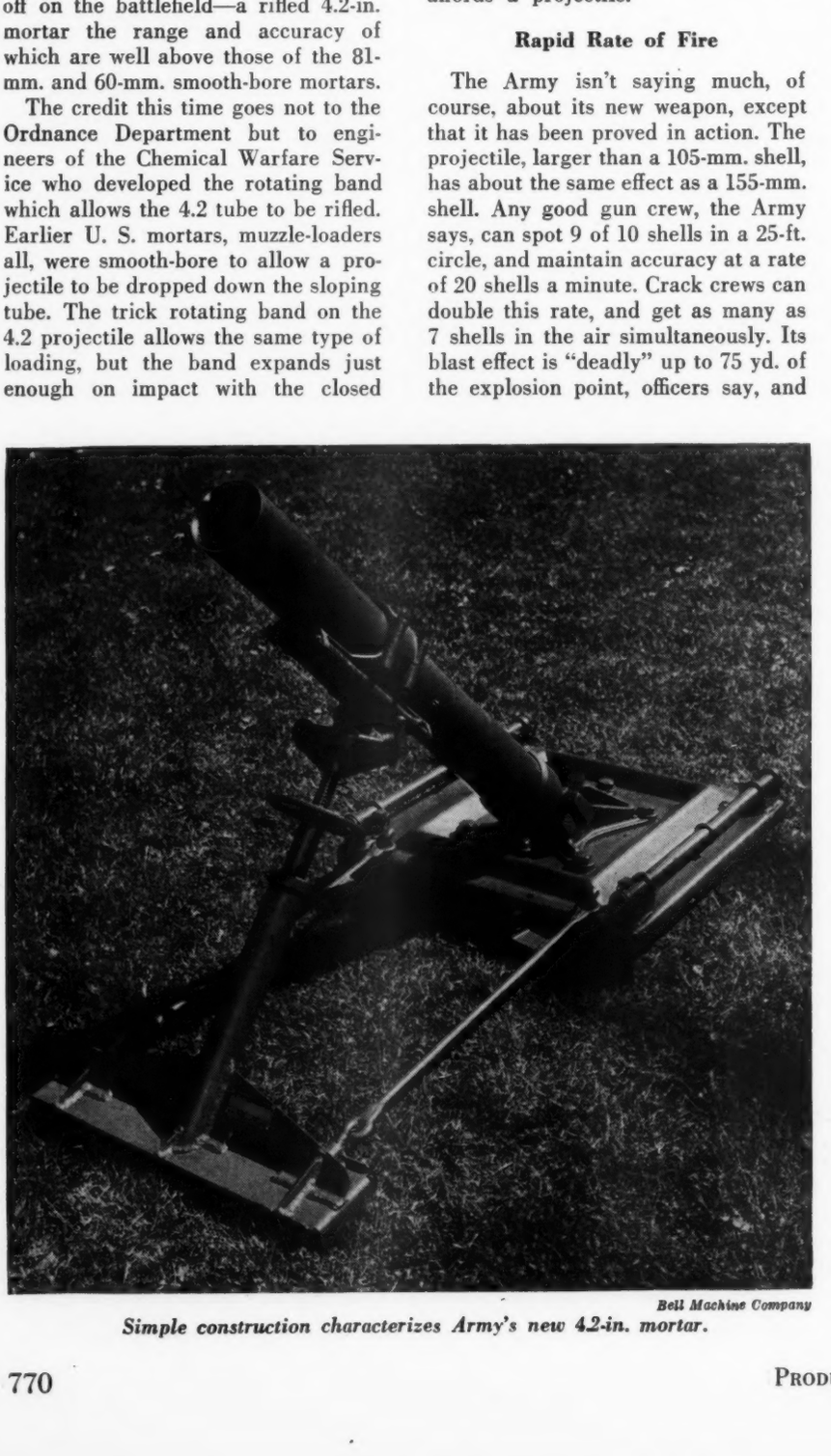
Rapid Rate of Fire

The Army isn't saying much, of course, about its new weapon, except that it has been proved in action. The projectile, larger than a 105-mm. shell, has about the same effect as a 155-mm. shell. Any good gun crew, the Army says, can spot 9 of 10 shells in a 25-ft. circle, and maintain accuracy at a rate of 20 shells a minute. Crack crews can double this rate, and get as many as 7 shells in the air simultaneously. Its blast effect is "deadly" up to 75 yd. of the explosion point, officers say, and shell fragments will kill up to 175-200 yd. In addition to fragmentation shells, smoke and white phosphorous projectiles can be fired. The 4.2 proved itself, among other places, against German tanks at Salerno and against Jap "bunkers," hidden, buried jungle strong points, in the South Pacific.

While the 4.2 is the first rifled mortar used by U. S. troops in modern warfare, it is not the first to be used anywhere. The Jap "knee" mortar, (PRODUCT ENGINEERING, Feb., 1943, p. 65) is rifled, as is another small, breech-loading mortar developed by the Italians. Both of these weapons, however, are of much smaller caliber, and disdained by U. S. weapon designers whose whole aim is to hit the enemy with as large and powerful a projectile as can possibly be used in the given situation.

The 4.2's mobility is good, equal to that of its smaller counterparts as long as a full crew is available. The 81-mm. mortar employs a three-man crew, one lugging the base plate, another the tripod and the third the tube. The 4.2 takes two men to the base plate, one to the tripod and another to the tube.

The 4.2 is manufactured by the Bell Machine Company, of Oshkosh, Wis., which was recently awarded an Army-Navy "E" for its record on the new weapon. Before the war, Bell made precision machinery, much of it for woodworking.



Bell Machine Company

Simple construction characterizes Army's new 4.2-in. mortar.

WARTIME SUBSTITUTIONS:

One of the most striking wartime exhibits in Washington has been opened to the public by the War Production Board in the Social Security Building, gathering under one roof outstanding examples of material substitution and conservation by just about all of the government's numerous procurement agencies and many of their suppliers.

At least 2,000 exhibits, ranging from web harness for horses to a Canadian bomb thrower, and covering minutely such fields as merchant and naval shipping, aircraft, ordnance, consumer durable goods, communications

equipment, plastics and many others, are included in the show, much of the credit for which goes to WPB's Conservation Division and its director, Howard Coonley.

The section devoted to substitutions and redesigns in aircraft manufacture contains some of the most striking examples of conservation. One exhibit contrasts a centrifugally-cast landing gear pivot with its 18-piece fabricated predecessor. The casting stood up under a load of 480,000 lb., when the design load was 209,000 lb.

Redesign of 434 aluminum-alloy riveted assemblies for spot welding saved 116.5 man-hours per airplane. A new design for a landing gear spring—three rubber, air-filled bellows mounted horizontally on the main strut —saved considerable material, man- and machine-hours and provided a spring which would support 30,000 lb. for 6 lb. of weight. Normal automobile leaf springs, by contrast ,support between 800 and 900 lb. with 20 lb. of weight.

Molding vs. Machining

A molded plastic vacuum and manifold filter block replaced a block machined out of bar stock. The plastic block weighed 0.22 lb., cost 11 cents and was fabricated in 15 min. Its predecessor weighed 1.23 lb., cost 60 cents and took 36.6 min. to fabricate. This was a development of North American Aviation Company.

One substitution which did a better job than its predecessor was a laminated, fabric-base phenolic sheet for a tail turret expended-ammunition hopper. It replaced a welded aluminum alloy sheet and actually wore better than the metal. The laminated sheet weighed 1.25 lb., cost $1.43 and required 0.19 hr. fabrication time. The metal sheet weighed 1.60 lb., cost $2.90 and required 1.10 hr. for fabrication.

By replacing critical SAE 4330 seamless-steel tube with non-critical SAE 4330 plate, the American Propellor Company used 270 lb. less steel per propellor, cut scrap from 40 percent to 5 percent, and substituted 20 semi-skilled man-hours for 60 skilled man-hours.

Elsewhere in the exhibit are such examples as redesigned forgings for the Bren light machine gun which saved many man- and machine-hours on a vital product; substitution of malleable iron or steel for bronze in alarm gongs and similar items, saving more than 275,000 lb. of bronze yearly in alarm gongs alone. Ship's bells for the Navy are made of pressed steel rather than bronze, and galvanized chain replaces manila rope in ship's pilot and escape ladders, saving 2,589,400 lb. of sisal fiber yearly.

ROCKET LEFT BEHIND BY GERMANS

Photo by U. S. Army Signal Corps.

When the Germans evacuated a defense position in Italy they left this rocket behind. The Army won't say much about it except that it is a rocket and that it is fired from the frame in which it rests. The frame may be of either metal or wood and need not be elaborately emplaced for firing. Range of this weapon is not disclosed. Obviously, its accuracy is low in relation to that of a field piece. Such weapons are best used as "area" weapons, with a number of them trained on a particular area without much regard to specific targets. Weight of the rocket was not given.

COMMUNICATIONS DESIGN:

"German radio is five years behind our own in design, components and construction," according to a report compiled on the North African battlefront for the chief signal officer. Nazi communications equipment is "obsolete by American standards," the report went on, apparently because the Germans standardized their equipment in the preparatory 1934-38 period and have been unable or unwilling to improve upon it since. Italian radio equipment was worse than the German matériel, the report added.

German radios are strong and mechanically well built, heavier than ours and capable of withstanding considerable punishment. They lack water and dust-proofing, which deficiencies were only poorly made up for by the stop-gap use of tapes and sealing compounds. "An obvious fault was the lack of impregnation of coils and transformers to keep out moisture," the report, compiled by Capt. James P. Lipp, declared.

German signal prisoners seemed not too well trained along technical lines but were good operators, Capt. Lipp found. Some captured sets were sealed to prevent tampering by German operators who might seek to make their own repairs.

FIGHTER RETURNS SAFELY DESPITE SHELL-TORN WING

Photo by U. S. Army Air Forces

It wouldn't be much fun to fly home from enemy country in a plane damaged as badly as this one, but Lt. Justus Foster, of Junction City, Ky., did just that, returning safely to an English base from a battle over France in which enemy fighters virtually destroyed his wing with five 20-mm. explosive shells. Note the small margin by which the tire remained on the wheel. The propeller damage must have been suffered in nosing over while landing. This is another of the miracles of stamina and durability which U. S.-built planes are demonstrating almost daily in widespread battle areas. This fighter airplane is a Republic P-47 "Thunderbolt."

CARRIER RESCUES TANKS AND SAVES GASOLINE

Photo by U. S. Army Signal Corps

Another unit of the Army's special mobile equipment is this M-25 Tank Recovery vehicle, used not only to bring disabled tanks out of battle and back to repair shops but also to move tanks up to the scene of battle wherever feasible, allowing them to enter the fight with cool motors and full fuel tanks. The tractor-trailer arrangement is 58 ft. long and weighs more than 40 tons. The tractor is well armored and mounts a .50-cal. machine gun for anti-aircraft defense. It carries as standard equipment enough ammunition, fuel and rations for its crew to enable it to operate away from its base for four days. Winch drags disabled tanks onto the trailer.

Professionals Without a Profession

ANYONE who has the desire to do so can hang out a shingle as an industrial designer. There are no established professional requirements for industrial designers, nor are they required to have state licenses such as required of professional engineers. There is no recognized authoritative association of industrial designers, nor an official listing of them. Hence, they do not have a code of ethics to which they must subscribe.

A great many factors have contributed to the failure of industrial designers to organize into a professional body. Perhaps the greatest hindrance to their progress is the delusion under which some of them labor that they are professional men belonging in the same category as the three learned professions—theology, law and medicine. They naturally belong, in fact, to the industrial professions such as engineering, research, management consultants and similar professions. They do not render personal services, but rather business services that translate into dollars, profit or loss.

Another hindrance to the proper organization of industrial designers into a profession can be attributed to the failure of most of the recognized and competent designers to exert leadership. A few prominent men are sincere in their desire to form an effective association. But they are discouraged from doing so by industrial designers who exhibit a derisive attitude toward most of the other designers, including even those who have done highly creditable work but have refrained from building large organizations and palatial offices.

Several unsuccessful attempts have been made in the past to organize industrial designers into a professional calling. The present American Designers Institute appears to be a sincere attempt on the part of a few earnest designers to create the type of organization needed. Unfortunately, this organization seems to have put the cart before the horse in placing major emphasis on large membership rather than the development of a code of practice and professional requirements. Furthermore, A.D.I. is not receiving support from some of the better known industrial designers.

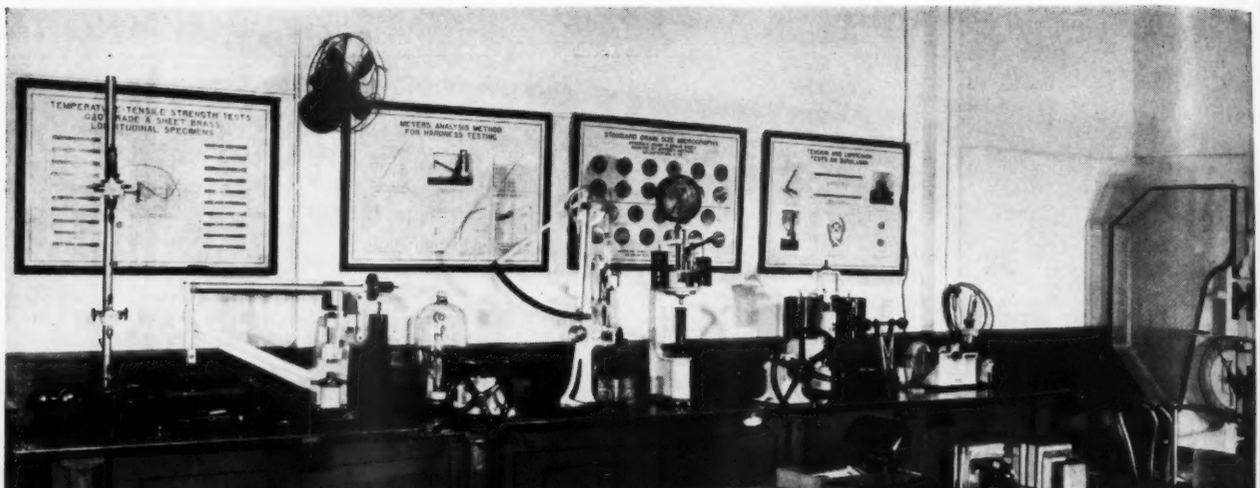
Small and medium-sized manufacturers in particular have much to lose from the failure of industrial designers to get together. Industrialists seeking the services of competent designers have no dependable and established means for finding out who, what and where the desired consultants are. Even the basis of compensation is not established. Results are too often disappointing.

Industrial design consultants will eventually be penalized. Continuation of the present state of affairs will drive many of them out of business, regardless of size and reputation. Companies are being encouraged, or rather impelled, to hire an industrial designer as a full-time employee, rather than as a consultant.

It would be well for industrial designers to forget temporarily their self designation as "highbrow professionals" and start operating among themselves on a sound businesslike basis. Webster defines the word profession as a "Collective body of persons engaged in a calling." By this definition, absence of collectivism among industrial designers makes them professionals without a profession.

Now is a propitious time for industrial designers to form a representative association, establish a code of ethics and professional requirements, and seek a legal professional status. It is a job for a handful of the country's recognized designers of proven performance. To do it they must throw temperamental discord, pet peeves and distorted conceit out of the window.

G. F. Nordenholt



Post-war development projects are being studied in physical testing laboratories of industrial engineering departments throughout the nation. A typical portion of the testing equipment used by the Bell Telephone Laboratories, Inc., is shown. Charts on the wall deal with temperature-tensile strength tests, hardness testing, grain sizes, and tension and corrosion tests.

Engineering Organization For Post-War Product Development

Presenting a summary of post-war planning as discussed by 16 chief engineers at a recent meeting in Cleveland, Ohio. Problems facing the chief engineer in planning the redesign of old products or the development of new items were reviewed at length and procedures for their solution were considered.

ENTERPRISING companies throughout the nation are thoroughly conscious of two basic engineering responsibilities necessary to post-war progress: Improvement of accepted peacetime goods and development of new products. These companies are not relaxing their wartime production schedules, but they are protecting their interests by organizing now for post-war operation.

These facts were revealed at a recent meeting of 16 chief engineers in Cleveland, Ohio. The morning session was devoted to personnel problems and was reviewed on page 704 in the November number.

Making full use of expanded plant facilities as insurance against wholesale unemployment when war production begins to taper off or halts is recognized by company executives as of prime importance to the nation's welfare. It goes hand in hand with successful plant conversion.

Engineering departments have unalterable responsibilities in the opera-

tional plans of companies. One engineer at the Cleveland meeting summarized his firm's operational plan as follows: "The product must have soundness, and the company must know that the product is acceptable." The soundness phase is the strict responsibility of the engineering department. Knowledge of a product's acceptance rests with the engineering and sales departments' field men who visit customers and obtain first hand information on performance of the product and its salability.

Several chief engineers asserted that products are sold today on the basis of merit rather than the high pressure salesmanship of years past. This is undoubtedly an outgrowth of heavy competition, but it serves to bring out forcefully the contribution of the engineering department to a new design's success. It accentuates the importance of a chief engineer having necessary authority and a proper position in the corporate structure.

To insure cooperation among engineering, executive and sales on new developments, one company established an engineering committee made up of a director, chief engineer, the chief draftsman, the development engineer and a laboratory engineer. This committee meets regularly once a week—more often if necessary.

Management must depend upon the engineering department, according to one of the men present, but must not ally itself so closely that the engineering department is influenced to the point of thinking along the lines of management. In this man's opinion, the fault may lie on both sides. Management is helpless if engineering cannot develop a product that will sell. On the other hand, if money is not made available for development work it is obvious that the company will fall behind competition.

Finding New Products

The post-war thinking of these companies is not confined to the redesign of peacetime machinery. Many of them are considering going outside their former manufacturing field for new products. Some have used advertising, others call in outside industrial designers to suggest new products, still others use field research as a means of product initiation.

A representative of one of the larger companies reported his firm is confronted by two post-war problems. First of all, it must improve the design of the present line of tools in order to have a salable product in the machine tool market. Secondly, in order to fill out expanded plant capacity, products in entirely new fields must be developed. Insofar as redesign work is concerned, the firm is using the engineering department and the production department to establish a criterion for better designs. Several men of both departments are constantly out in the field studying machine performance and determining what must be corrected in the new design.

Allied Lines

In developing a new line of products, one executive engineer pointed out that it would be wise to have these new lines of products allied to the present sales organization set-up, otherwise new sales outlets must be found. Another point in this connection is that a new product in an allied line will utilize much of the present manufacturing equipment.

One company which advertised in magazines and newspapers for ideas on post-war products received some interesting but also a great many negative results, including one or more designs offering perpetual motion. Many of the patented designs submitted were not practical, revealing a serious defect in the nation's patent system. In some instances, the claims were drawn up poorly and were practically worthless. Surprisingly enough, it turned out that even larger companies at times apparently take out worthless patents which they had thought to be of value.

Five companies reported maintaining their own patent departments. Many of the companies represented had investigated the patents held by the Alien Property Custodian. Not much of appreciable value was disclosed, although one or two were of some interest. An amusing incident was that one company found a patent of its own in the Alien Patent file.

Most of the engineers present felt that some sort of field testing is necessary before engineering work can be done on redesign or on new products. One company uses an independent opinion research service. This service furnishes trained interviewers who go out and talk to the company's sales divisions throughout the country for opinions on selling policies.

These field men also interview users of equipment to find out what they think of product performance in service and what their reactions are to the sales methods employed to sell the product. This company feels that it has been well repaid for this research activity because it has received valuable information for product improvement. Of equal importance, this survey showed where sales methods could be changed to advantage.

This same company supplements these basic interpretations of public attitude, complaints, criticisms of company advertising and similar factors by having their own executives go out and work in the field. For instance, every year all sales executives have to sell a definite quota of household equipment by house-to-house canvass. In this way these men receive first hand experience on marketing problems. Engineers do not have to do any selling but have an equivalent program on service duty, going out and working on repairs on a house-to-house basis. Obviously, this gives them an unequaled opportunity to talk with the users of the equipment and to obtain first-hand information on good and bad points of the product.

A similar procedure is employed by a leading manufacturing company which does not use an outside organization. Instead the company calls in several of its engineers from the field who were formerly known as service engineers. These men are sent out to tour the country and talk to users of this type of machine tool, not necessarily the company's own product, but any competing brands of tool designed for the same purpose. The company has accumulated a vast amount of data on tool performance and can tell just why today's designs are efficient or inefficient. These data are particularly useful in determining faults in their own machines. The field reports also serve to give the company a definite idea of what types and sizes of such machines are most popular, and should be improved first.

Organizing for Product Development

Every company represented at the meeting is actively working on post-war product development. This does not necessarily mean that the developments are at the blueprint stage, but does mean that steps in organizing the engineering department for such activity are being taken. For instance, one large tool company has a post-war planning committee made up of five men. The men forming the committee are the assistant sales manager, three field engineers and one executive engineer. In addition they can call on anyone in the organization for assistance. Post-war committee work takes priority over any other company activity aside from war production. To tie in with management, the chairman of

this post-war committee meets with the Board of Directors once a week.

Another manufacturer's post-war planning is headed by sales department men who work in close cooperation with the engineering department. Engineers attend regular meetings. A printing machine company has a committee headed by the vice-president in charge of sales who acts as chairman. The chief engineer sits in on the meeting. This enables the engineering department to keep in close touch with the thinking of the sale executives on post-war activities.

Several of the companies represented at this meeting were conscious of the fact that so many new developments are taking place during the war years that it is necessary for them to catch up with the times. As one man expressed it, "Rebuild your thinking before you rebuild your product." To implement this, the company is sending its engineers to a nearby college where they take courses in electronics, new materials, and other recent developments.

Another leading engineer pointed out that his company set-up insofar as post-war product development is concerned follows: "A special committee consisting of the president, sales manager, the executive vice-president in charge of production, and chief engineer analyze possible products and decide on those that might be good prospects for future development. After these products are tentatively decided upon, a group of regional sales managers are called in and given a picture of what is planned. At this meeting, only an over-all summary of post-war thinking is presented. This is done to get the opinion of these men who, after all, will have to sell and service the product. When models are shown at such meetings they are wooden mock-ups.

According to another engineer, post-war planning must proceed on the following basis: "How can we sell what we make now in competition with other companies? How can we find other things to make? The first question can be solved by field investigation among users, the second is a rather difficult proposition and must be handled by development committees and research."

In this connection, one company sends a form sheet or questionnaire to regional sales managers. These men have their customers fill out the questionnaires. Thus, facts regarding customer desires for post-war lines are established. This is most helpful in redesigning equipment.

The discussion at one point turned to the question of using engineers who are working primarily on war equipment for post-war design. One company puts over-age men on post-war work and supplements their activities with the younger men who are on a draft deferred basis but who at the moment have nothing to do in connection with the war effort. Another company pointed out that many of its engineers perform post-war work at slack times but are immediately assigned to a war project upon its receipt.

There seems to be little or no trouble in getting small amounts of material for laboratory experimentation. Insofar as this work is concerned it has been found that Washington is receptive to the extent of allowing materials for research when such materials are only a small fraction of the total used for war. In addition, Washington feels such activity is for the public good.

Specialists in engineering have been found to be valuable to one company. The chief engineer of this company believes that every manufacturing concern should recognize that specialists such as hydraulic and electronic engineers must be hired in order to get the most out of war developments, because of the increasing complexity of problems facing the design engineer. One company sends certain engineers to plants such as General Electric, Radio Corporation of America and others so that they can get posted on the latest developments in radio, electrostatic heating, motors, materials and techniques. In fact, every company represented at the meeting was doing the same thing and they all believed it would be a fine idea for every manufacturing concern to have liaison engineers traveling around collecting information on new developments.

Industrial Designers

Several of the chief engineers said that industrial designers capable of engineering thinking are of considerable help in the development of new products. It was the consensus that any results achieved by the outside industrial designer depend to a great extent on his personal attitude and relations with the engineers of the company employing him.

Apparently one successful method of retaining the services of an industrial designer is to set up a budget in such a way that the designer is paid a fixed rate plus a specified amount per hour for drafting services.

One engineer stated that the best thing his company obtained in working with an outside industrial designer was a new viewpoint on product development and stimulation to the engineering department. This remark was supplemented by another engineer who pointed out that the industrial designer will often direct thinking into the channels that the engineer himself would never think of. Used correctly, there is no doubt that the consulting industrial designer has an important position in product development. They are valuable in suggesting new products, in stimulating the use of new materials and in getting company heads and engineers conscious of product appearance and product marketability.

SOME POST-WAR DEVELOPMENT SUGGESTIONS AS OUTLINED BY 16 CHIEF ENGINEERS

FUNCTION I—REDESIGN OF REGULAR PRODUCTS

A. Engineering Department Analysis: Machine efficiency; materials; control accessories; production methods.

B. Consumer Research: Service qualities of product; improvement suggestions; determine preferred sizes of products; evaluate competitive standing.

C. Engineering Field Research: Determine operating characteristics and quality of design; serviceability; possible means of increasing machine efficiency.

FUNCTION II—DEVELOPMENT OF NEW PRODUCTS

A. Engineering Department Studies: Available materials and parts; available plant facilities and production machinery.

B. Outside Consultants: Study market opportunities; suggest new products for a particular field or company; outside point of view to stimulate new developments.

C. Engineering Field Research: Visit plants throughout country; survey possible new machine requirements of manufacturers.

D. Advertising: Encourage independent engineers and outside companies to submit new product ideas for development.

Conservation in Ordnance Production

Conservation recommendations from engineers and employees are embodied in this chart prepared by the Ordnance Division of the Otis-Fensom Elevator Company, Hamilton, Ont., to guide savings in the production of war materials. The chart is divided into three main conservation headings, "Material, Time, Money." Sub-headings present a complete breakdown of the conservation aspects of each item. The chart propounds eight questions to be checked to determine possible savings in the production of war equipment.

MATERIAL

Substitution

Non-Ferrous
- Use of plastics
- Preformed material
- Substitution of ferrous material

Ferrous
- Use of plastics
- Use of preformed material
- Use of low alloy for high alloy and heat-treatment
- Use of case hardening in place of high carbon
- Use of plating in place of stainless steel

Redesign of Parts

- Replacement with standard parts
- Combining parts
- Making one part as two-piece assembly to save material
- Welding in place of other fastenings

Built-up Tools

- Carbide tips
- Inserted teeth
- High-speed tips

New Processes of Manufacture (Even where initial cost is higher)

Use of Preformed Material
1. Extruded shapes
2. Forging
3. Die-castings
4. Sand-castings
5. Stampings
6. Tubing for solid

Welded Assembly

Shrink Fits for Threads

TIME

In Manufacture

- Processes
- Types of Machines
- Types of Material
- Incentives

- Use of standard parts
- Use of free machining materials
- Use of welding in place of rivets
- Use of conveyer systems
- Use of multiple spindle machines
- Use of automatics
- Use of spot welding
- Chrome plating or nitriding tools to prolong life
- Use of preformed material
- Use of better coolants
- Use of shrink fits for screw threads
- Use of wage incentives
- Use of turret lathes
- Redesign of fixtures and jigs

In Assembly

- Combining parts
- More complete gaging in manufacture
- Using devices such as lock nuts, terminal links
- Special tools, fixtures
- Wage incentives
- Competition
- Use of drive screws

In Heat-Treatment

- Elimination where not essential
- Re-arrangement of facilities
- Use of continuous furnaces
- Devices for holding in quenching
- Pre-testing for hardenability before machining

MONEY

Salvage

- Welding broken parts
- Straightening
- Brazing broken tools
- Re-heat-treatment
- Building up if undersize:
  1. Metal spray
  2. Weld metal
  3. Plating
  4. Bushings

Less Man-hours

- In Manufacture
- In Assembly

Reducing Machining Times

- Preformed material
- Free machining material
- Use of turret lathes
- Use of multiple spindles
- Use of automatics

Less Expensive Material

- Brass for bronze
- Ferrous for non-ferrous
- Standard steels for specials
- Use of synthetics

THINGS TO CHECK –

1. Will a less expensive standard material do?
2. Can a free machining material be used to increase tool life?
3. Can any alternative form of stock be used?
   (a) Extrusion
   (b) Tube for rod
   (c) Forging
   (d) Stamping
   (e) Sand-casting
   (f) Die-casting
   (g) Welded construction
4. Can speeds and feeds be increased?
5. Can standard part be used instead?
6. Could parts be redesigned?
7. Can parts be doubled up?
8. Would it save to make the part a two-piece assembly?

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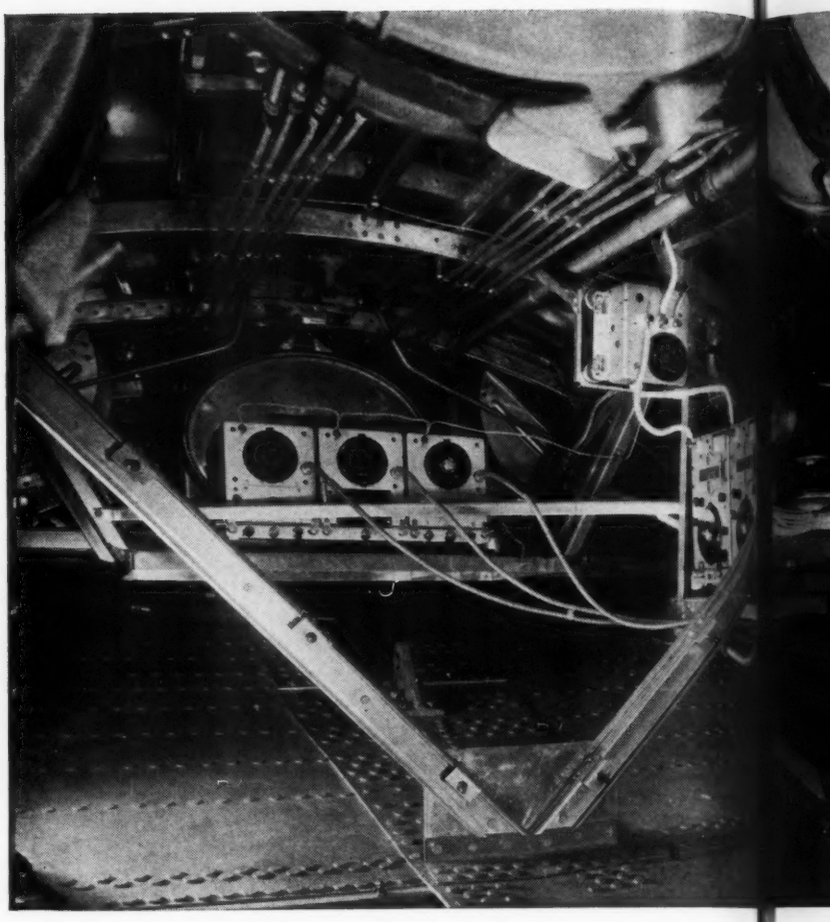

Electrical Aircraft Systems Reduce Vulnerability of Planes

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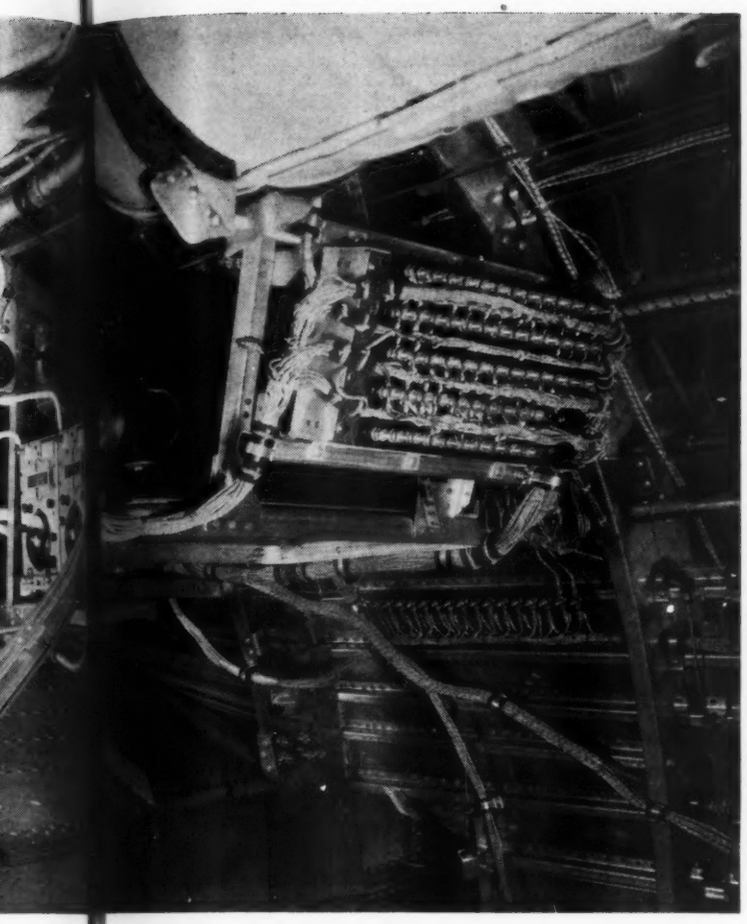
Presenting a thorough comparison of electrical and hydraulic systems from the standpoint of aircraft accessory operation. Increased safety aspects of the electrical system, trends toward reduced generator and motor weights despite increased horsepower, important control factors, and maintenance advantages are emphasized.

A CURRENT question in aviation circles is: Should an airplane accessory system be hydraulic or electric? As is so often the case, proponents discuss their subjects in profound and learned terms, but fail to go beyond vague generalities.

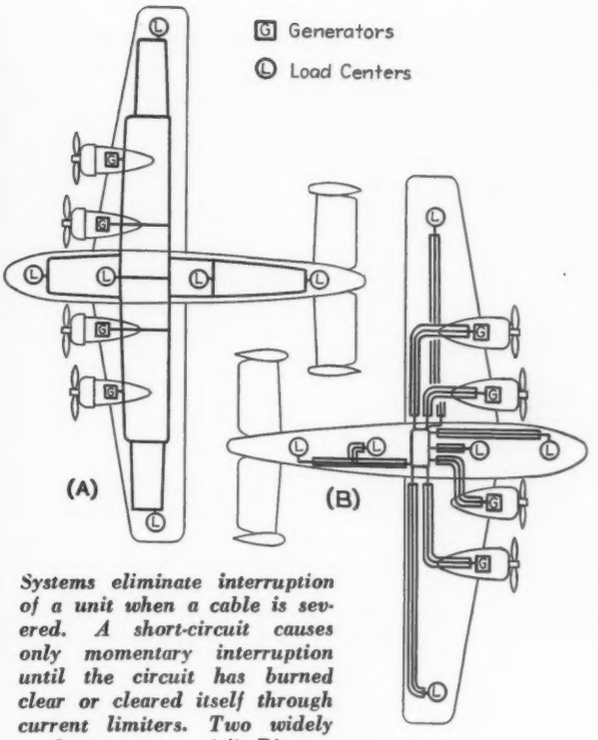
Reduction of the argument to a specific case will invariably precipitate a sufficient number of facts so that an orderly and intelligent engineering solution can be obtained. The correct solution, be it either electrical or hydraulic, should depend solely upon the requirements of the particular case and not personal prejudice.

The human element cannot be neglected, however. Specific advantages and disadvantages of a system are greatly modified by the abilities of the engineers who design them and the competence of the men who execute the designs.

Aside from the specific function



Labyrinth of wires and circuits which are part of the radio hook-up. The three command receivers, two command transmitters, radio relay panel and radio compass receiver are shown in a Liberator bomber.



Systems eliminate interruption of a unit when a cable is severed. A short-circuit causes only momentary interruption until the circuit has burned clear or cleared itself through current limiters. Two widely used systems are: (A) Ring or loop bus system. (B) Triple bus radial system.

which is to be performed, such as providing landing lights, operating the radio equipment, changing the propeller pitch, and operating brakes, there are certain other general factors which influence the selection of the accessory system.

Any system, whether it is hydraulic, straight mechanical, pneumatic or electrical, must first of all provide reliable operation. Aircraft electrical equipment has in the last two years increased many fold in reliability. Development of high-altitude brushes, high-speed bearings, low temperature greases, special balanced type and vibration-proof relays have all contributed to make aircraft electrical systems extremely reliable. The electrical system is now practically unaffected by altitude or temperature. When the switch is closed, the current flows; there is no changing viscosity or flow of an electrical current. Reliability has been greatly increased by use of current limiters, circuit breakers and fuses. An electrical system eliminates troublesome packings, gaskets and check valves.

War conditions and military requirements have imposed new design factors, many of which were never considered under peacetime operations. One important consideration in the design of aircraft is its vulnerability to gunfire. Before the war, landing gear, flaps, engine controls and other accessories in many airplanes were operated hydraulically. With the addition of armament and the militarization of aircraft, the hydraulic system increased in size and complexity. In a proposed design for a large bomber it was estimated that it would require 400 lb. of hydraulic fluid alone to operate the various mechanisms.

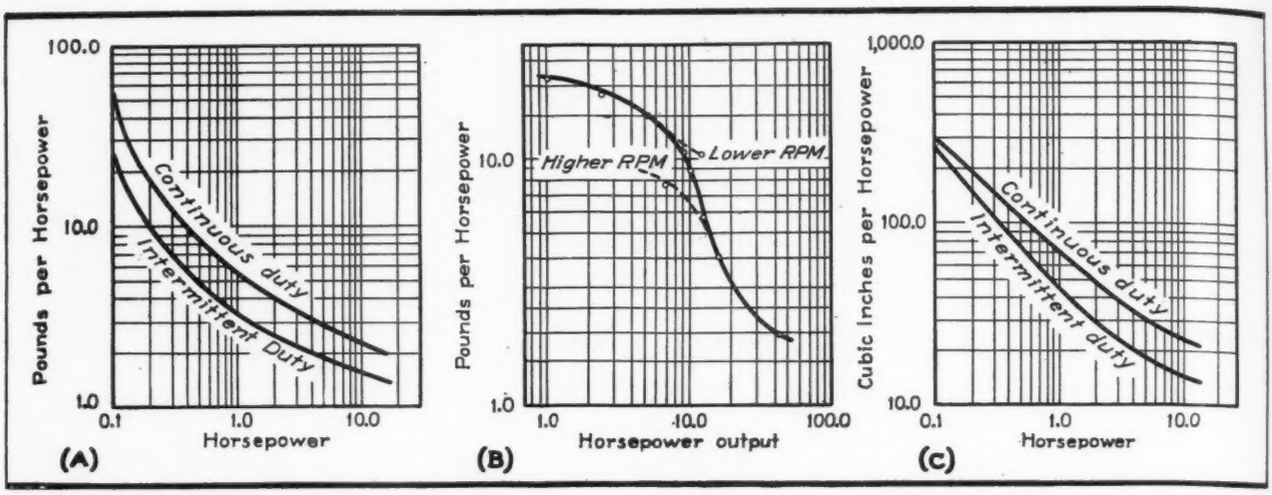
In the early days of the war, engineers realized that the large concentration of hydraulic lines and selector valves in the flight deck, as well as connecting lines, hydraulic accumulators, pumps, actuators and other items constituted a definite hazard from gunfire. Aside from the functional failure of an entire system from gunfire causing loss of pressure and fluid, there is also a definite fire hazard.

In many airplanes the hydraulic systems were replaced by electrical to reduce vulnerability. An electric wire or cable is smaller than a hydraulic line and can be more easily concealed behind structures which afford some measure of protection.

A cable or wire is either severed or shorted in a direct hit by gunfire. If shorted, it invariably burns itself clear in a short time, resulting in an open circuit. This is particularly true for the 24-volt systems now being used. Only apparatus tied to the open circuit stops functioning. The rest of the system is not affected. More recently, parallel feeder and ring distribution circuits have been developed. If a feeder cable or wire connecting some piece of apparatus is hit causing an open circuit, parallel branches of the circuit continue to supply current.

Improvement in the science and methods of reducing radio noise has virtually eliminated all conduit on an airplane. With wiring in the open, it is relatively easy to repair damaged wires even during flight. In modern aircraft, identification marks at each terminal facilitate identification and repair.

Multiplicity of electrical power sources has reduced airplane vulnerability. It is customary here and abroad



(A) Weight-power ratios of electric motors, of various ratings, which indicate trend of motor designs. An intermittent duty motor of 10 hp. weighs but 15 pounds. (B) Generator weights have been reduced with increases in total power, as indicated in this chart. The curve has been plotted from actual generator weights. Discontinuous extensions indicate the region in which the generator r.p.m. has been increased. (C) Graph of cubic inches per horsepower required by typical continuous and intermittent duty motors of various horsepower ratings. Higher speeds have enabled designers to reduce weight ratios.

to have a generator on each engine and many of the larger airplanes also have a separate gasoline driven auxiliary power plant.

The various generators and batteries are physically separated to reduce vulnerability. They are usually tied together in one of two ways: (1) Ring or loop bus; (2) parallel bus. In modern practice, power take-offs are made through current limiters; consequently, a short-circuit in any electrical component, or portion of the distributing system, causes the respective feeder to clear itself and isolate the faulted section. This combination results in a system capable of taking terrific punishment.

Weight Comparisons

On a weight basis, the electric systems of a few years ago were poor competitors of the hydraulic. Weights of generators, motors, switches and circuit breakers were extremely heavy. Electrical designers were bogged down in a quagmire of conventionalisms and designs predicated by the power industry where extremely long life and reliability were of major importance and weight of no consideration whatsoever.

Under the pressure of aircraft requirements, weights and sizes have been reduced to an unprecedented low. Elctrical designers unfamiliar with aircraft design will throw up their hands and shout, "Impossible," when shown specifications on apparatus which is currently being installed in aircraft. For example: A 5KW aircraft generator weighs but 32 lb.; 400 amp. 30 volt generators have been built that weigh only 67 lb. The physical size has been reduced in proportion to the weight. Compare this with commercial generators whose weight is measured in hundreds of pounds.

Electric motors have also been reduced in size and weight. For example: Electric motors of $\frac{1}{10}$ hp. rating which, complete with a magnetic clutch and brake, weigh only 0.90 lb.; a 4 hp. power unit for intermittent operation weighs only 17 lb. complete with brake and magnetic clutch. These lightweight units found quick application where rotational or angular displacement of an electric motor could be used to advantage.

For linear translation and where a straight thrust force was required, hydraulic jacks with simple construction of piston and cylinder are being replaced by light, highly efficient electric screw jacks. For example: The aircraft industry is now using screw jacks which weigh only 2¼ lb. with motor and develop a thrust of 500 lb. at a speed of 10 in. per min.; another develops a thrust of 2,000 lb. and weighs only 5½ lb. complete with motor.

High efficiency ball-bearing electric screw jacks weighing only 162 lb. with motor have been developed to support a static load of a quarter of a million lb. and deliver a thrust of 83,000 lb. The maximum diameter is less than 7 inches.

As the size of electrical systems has increased, the specific weights have decreased. When only a few fractional horsepower motors were used per airplane there was not so much emphasis placed on the weight ratios but, as the systems grew in size, weight became a more important factor. An intermittent duty motor of 10 hp. weighs but 15 lb. For fractional horsepower units the lb. per hp. ratio seems excessively high. The definite minimum weight of bearings, shafts, case, mounting brackets and connectors is responsible. Further reduction of this weight, regardless of the power of the motor, would be unpractical.

Generator weights have been greatly reduced with increases in total power. Higher speeds have enabled designers to push the weight ratios to new low levels. Both generator and continuous duty motor weights in the large size have been brought down to around 2 lb. per horsepower.

In general, the distribution of electrical energy can be accomplished with considerably less weight than for an equivalent hydraulic system. In good aircraft design, one horsepower of electric energy can be transmitted 100 feet for a weight of one pound. Customary practice is to allow 3 percent loss for continuous duty and 6 percent loss for intermittent duty. This is, in general, a higher efficiency than that for which a hydraulic system is designed.

In smaller airplanes in which the total accessory power is in the neighborhood of 5 to 10 hp., the fixed weight of a hydraulic system is frequently some 30 percent less than that of an equivalent electrical system. However, on the basis of a given set of operational conditions this ratio may be reversed because of the lower

operating efficiency and additional fuel which must be carried to maintain the hydraulic system in continuous operation. However, a comparison of the two systems is difficult to make on this basis unless the specific operations and duty cycles are known.

Most hydraulic accessories are operated only for short periods of time, and therefore the efficiency is not too important; whereas many of the electric loads are of a continuous nature and the power consumed integrated over the total period of flight may become important.

Installation and Maintenance

With the advent of open wiring, an electrical system is extremely simple to install and maintain. Aircraft wiring is now almost entirely done on wiring benches and cabling boards. The wire harnesses are laced up as sub-assemblies on peg-boards and then placed in the airplane. Quick disconnect connectors have been developed which further simplify the installation. Hydraulic lines must be preformed and carefully located and fitted into the airplane; they lack the extreme flexibility of stranded cables.

Electric wires can be readily repaired in the field, and in combat they are often repaired in flight. This ease of maintenance represents one of the outstanding advantages of an electrical accessory system over a hydraulic system in a military airplane.

From an installation standpoint, switches and cables of an electrical system are of considerably less bulk than the valves and lines of the hydraulic system.

Control Factors

In general where it is desirable to have variable speed of linear actuation or variable thrust the hydraulic system has been much simpler to control. A notable example of this has been the hydraulic brakes. However, these now have their electrical counterpart which has been finding a considerable application in the heavy truck and trailer field. Electric brakes are now commercially available in sizes of 9x1¾ in. to 18x6 in. and of 10,000 to 225,000 in. per lb. torque. They consume only 18-20 watts of power for operation.

Lightweight aircraft relays and remotely-operated switches provide a simple method of remotely operating electrical accessories. Limit switches provide a convenient method of controlling many operations and usually add only a few ounces to the installation. When added to hydraulic accessories, limit switches require additional wiring and the addition of some type of electrically-operated hydraulic valve which increases weight and complexity of the system. Remote positioning and position indication is also simple and reliable with the electric system; in most instances little or no additional wiring is found necessary.

Multiple operations or metering can be readily accomplished by means of stepping and selector type relays. Functions requiring specific sequences or time lags can be easily controlled by means of interval and time delay relays.

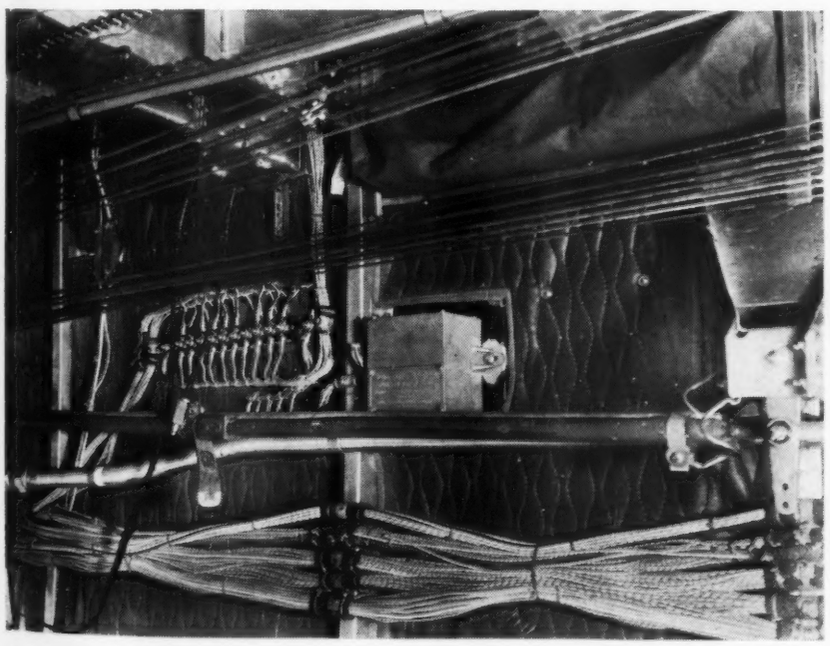
Electrical System Trends

In hydraulic systems it is to be observed that for the transmission of power at constant efficiency the ratio of pounds per horsepower per foot of distance transmitted increases with the transmission distance; whereas, in electrical systems this ratio remains more nearly constant. This statement must necessarily be qualified by many factors of design such as hydraulic pressures, frequency of power take-offs and comparative electrical system voltages. However, the comparison of several representative current aircraft designs of various sizes indicates this trend.

The trend of recent aircraft design has been toward electrical accessory systems, particularly as aircraft increases in size. As the size grows, the distances for power transmission also increase. For all practical purposes, electrical current is weightless, but the weight of hydraulic fluid in a long line is appreciable.

Although the advantages of electrical systems are more apparent in the large size airplane, there is a definite trend toward applications in smaller airplanes. For example: In the Focke-Wulf FW190, the flaps are actuated by electrically driven screw jacks and the landing gear folds up into the wings by means of a pinion gear with an electric driven worm. A particularly novel feature is that the tail plane incidence can be altered in flight; it is driven by an electric motor operated by two pushbuttons on the dashboard. A moving coil electrical indicator calibrated in degrees of incidence shows the relative position of the surface at all times. Propeller pitch change and brakes are the only hydraulically-operated accessories on the airplane.

With the limited space in most airplanes for accessory equipment, particularly at the rear of the engines, and the extreme service problems of military aircraft there is a decided advantage in unifying the accessories into one type of system. The choice of this system will depend primarily upon the functions to be performed and the above mentioned factors evaluated in terms of the specific design under question.



Multiplicity of circuits in the modern bomber is demonstrated by the conduits and cables in the foreground. Directly above, housed in a box, is the filter unit used for separating the voice in the radio hook-up from the beacon signal. A flip of the switch permits choice of beacon signals or beacon signal plus weather reports.

Stress Formulas For Non-Homogeneous Beams

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Consulting Engineer

Analysis of the strength of composite structures in bending, direct stress and shear. Equations derived for stress are based on the differences in the moduli of elasticity and the elastic limits of the non-homogeneous materials in the structure. Typical example is presented to demonstrate incorrect and correct methods of computation.

IN MODERN DESIGN, plastics, resin-bonded plywoods, aluminum alloys, steels and other engineering materials are frequently combined to reinforce each other. In such composite structures, the effects of the individual elastic limits and ultimate strengths on the strength of the part as a whole are seldom taken into consideration. It is incorrect to assume that the composite structure will have a strength equal to the sum of the individual strengths of the components, as this pre-supposes that the various materials act independently of each other, and that all reach their elastic limit, or ultimate strength, simultaneously. As the materials are intimately bonded together, they do not act independently, and since they generally have different moduli of elasticity and elastic limits, it is erroneous to assume that they operate with equal efficiency.

It is not always correct to assume that the weakest material will reach its elastic limit prior to the stronger materials reaching their elastic limits, as this depends on position in the structure and on individual ratios of elastic limit to modulus of elasticity. It is seldom realized that the strongest material may be the first one to take a permanent set; yet this occurs in many cases.

To make a true analysis of the strength of a composite structure, it is essential that the equations used take into consideration the differences in the physical properties of the materials, particularly in the modulus of elasticity and stress at elastic limit.

The standard stress-strain equations are based on Hooke's law, and therefore are only correct at stresses below the proportional limit. The same limitation will be present in the equations derived herein. In the few cases where ultimate strength is the only design criterion, it is probably best to develop the composite part by actual test rather than by computations, as such computations must take into account the shape of the stress strain curve above the yield point. Where more than one material is involved this becomes extremely complex. In general, most engineering elements are designed not on the basis of ultimate strength, but on the basis of serviceability. This pre-supposes complete recovery from the applied loads, and therefore requires that the imposed stresses be at, or below, the proportional limit. Under such conditions, the behavior of the materials conforms to Hooke's law.

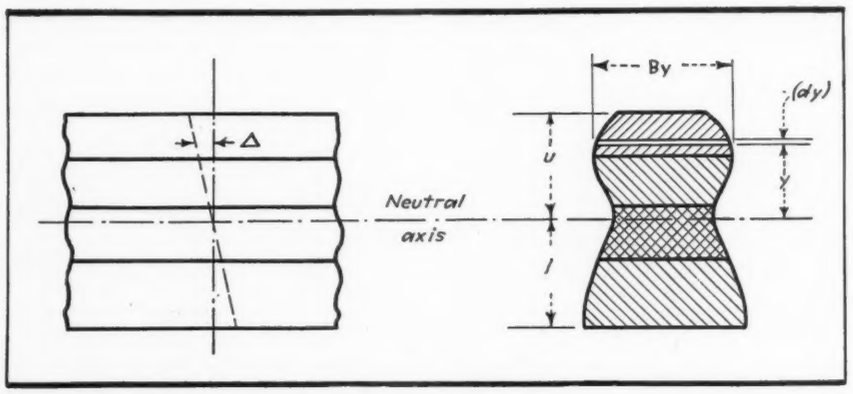


Fig. 1—Short length and cross-section of a structural member composed of four non-homogeneous materials.

General Equations

STRESSES CAUSED BY BENDING. Let Fig. 1 represent a short length and a cross-section of a structural member subjected to a bending moment, in which

B_y = width of any elemental area of cross-section at distance y from neutral axis of area of cross-section, in.
u = distance of extreme upper fiber from neutral axis, in.
l = distance of extreme lower fiber from neutral axis, in.
I = moment of inertia of cross-section, in.^{4}
M = imposed bending moment, in. lb.
f_{b_y} = stress normal to cross-section in elemental area $B_y\,dy$ caused by bending moment, lb. per sq. in.
f_{b_u} = stress in extreme upper fiber caused by bending moment, lb. per sq. in.
E_y = modulus of elasticity in bending of material at y distance from neutral axis, lb. per sq. in.
E_u = modulus of elasticity in bending of material in extreme upper fiber, lb. per sq. in.
E = modulus of elasticity in bending of a material, lb. per sq. in.
Δ_y = strain or deformation normal to cross-section at distance y from neutral axis, in. per in.
P_d = total direct load = total tension or compression load on cross-section, lb.
f_d = direct stress, tension or compression, lb. per sq. in.

The bending moment dM resisted by the elemental area is

$$dM = f_{b_y} B_y\, y\, dy \qquad (1)$$

Since

$$f_{b_y} = E_y \Delta_y$$

and since the strain Δ normal to any

elemental area is proportional to its distance from the neutral axis

$$\text{or} \quad \begin{matrix} \Delta_s = ky \\ f_{bs} = k\,E_s\,y \end{matrix} \qquad (2)$$

Therefore

$$dM = k\,E_s\,B_s\,y^2\,dy \qquad (3)$$

$$M = k\int_l^u E_s\,B_s\,y^2\,dy \qquad (4)$$

But $B_s\,y^2\,dy = (dI)_s$,

and

$$M = k\,\Sigma\,(EI)_l^u \qquad (5)$$

then since

$$k = f_{bs}/E_s\,y = f_{bs}/E_s\,u$$

$$f_{bs} = M\,E_s\,y/\Sigma\,(EI)_l^u \qquad (6)$$

$$f_{bs} = M\,E_s\,u/\Sigma\,(EI)_l^u \qquad (7)$$

When E is constant, that is, the same material throughout the cross-section

$$f_{bs} = M\,Eu/EI = Mu/I \qquad (8)$$

STRESSES CAUSED BY SHEAR. Using Fig. 1 again and letting

P_{vs} = total horizontal shear load per unit of length on a plane at y distance from neutral axis, lb. per in.

f_{vs} = horizontal shear stress on a plane at y distance from neutral axis, lb. per sq. in.

Q_s = moment area of cross-section between y and extreme fiber, about neutral axis (see Table I)

Q_u = moment area of cross-section between neutral axis and extreme fiber, about neutral axis.

S = vertical shear, lb.

On the basis of the theory that the horizontal shear load on a plane equals the summation of the change in load per unit length for all fibers outside the plane in question, the following equations can be derived.

$$dP_{vs} = df_{bs}B_s d_s = \left[\frac{d\,M\,E_s\,y}{\Sigma\,(EI)_l^u}\right] B_s\,dy \qquad (9)$$

But the vertical shear S equals $d\,M$, therefore

$$d\,P_{vs} = \left[\frac{S\,E_s\,y}{\Sigma\,(EI)_l^u}\right] B_s\,dy \qquad (10)$$

$$P_{vs} = \left[\frac{S}{\Sigma(EI)_l^u}\right] \int_s^u E_s\,B_s\,y\,dy$$

$$= \left[\frac{S}{\Sigma\,(EI)_l^u}\right] \Sigma\,(E_s\,B_s\,y\,dy)_s^u \qquad (11)$$

But $B_s\,y\,dy$ equals the moment of the elementary area $B_s\,dy$, defining the small but finite value of Q to be multiplied by the corresponding value of E at each successive value of "y" between y and u used in carrying through the tabular summation. Hence

$$P_{vs} = \frac{S\,\Sigma\,(EQ)_s^u}{\Sigma\,(EI)_l^u} \qquad (12)$$

Therefore

$$f_{vs} = \frac{P_{vs}}{B_s} = \frac{S\,\Sigma\,(EQ)_s^u}{B_s\,\Sigma\,(EI)_l^u} \qquad (13)$$

The corresponding equation for a cross-section of homogeneous material, that is, E is constant, is

$$f_{vs} = \frac{S\,Q_s}{B_s\,I} \qquad (14)$$

Table I—Summary of Formulas

Homogeneous Structures		Non-Homogeneous Structures	
Area	$A = \int_l^u B_s\,d_s$	Area × Elastic Modulus	$\Sigma(EA) = \int_l^u E_s B_s d_s$
Moment Area	$Q = \int_s^u B_s\,y\,dy$	Moment Area × Elastic Modulus	$\Sigma(EQ) = \int_s^u E_s B_s\,y\,dy$
Moment of Inertia	$I = \int_l^u B_s\,y^2\,dy$	Moment of Inertia × Elastic Modulus	$\Sigma(EI) = \int_l^u E_s B_s y^2 dy$
Direct Stress, tension or compression	$f_d = \frac{P_d}{A}$	Direct Stress at y, tension or compression	$f_{ds} = \frac{P_d E_s}{\Sigma\,(AE)_l^u}$
Bending Stress at y	$f_{bs} = \frac{My}{I}$	Bending Stress at y	$f_{bs} = \frac{M\,E_s\,y}{\Sigma\,(EI)_l^u}$
Horizontal Shear Stress at y	$f_{vs} = \frac{SQ_s}{B_s I}$	Horizontal Shear Stress at y	$f_{vs} = \frac{S\Sigma(EQ)_s^u}{B_s\Sigma(EI)_l^u}$

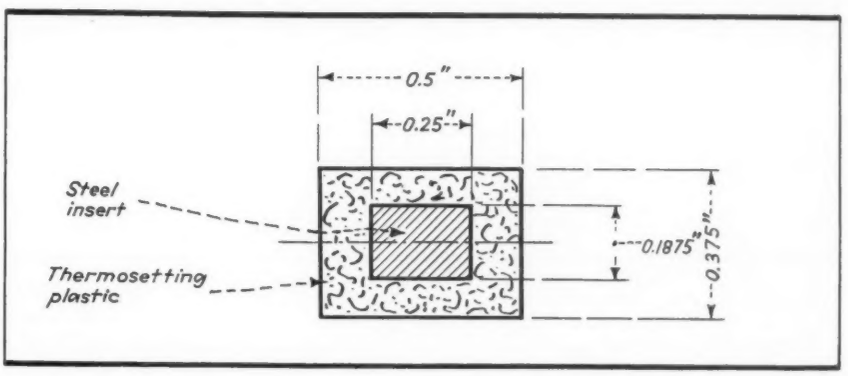


Fig. 2—Cross-section of a plastic bar having a steel core for reinforcement.

A comparison of the preceding derived equations for non-homogeneous structures with the equivalent standard equation shows that, in the former, the bending modulus of elasticity is included in the section properties as a variable, while in the latter, it is considered a constant.

From these derivations it will be noticed that the equations equivalent to the standard equations for area, moment area, and moment of inertia, all include the modulus of elasticity as a variable, and that these section properties must, therefore, be derived by integration. In most cases this is not as difficult as it first appears, since the modulus of elasticity remains constant for any particular material, therefore, integration can generally be accomplished by a "summation by parts" or tabular integration indicated by Σ, in which that portion of the section properties contributed by each material is computed independently and the over-all section property is the sum of these portions or parts.

For ready reference, Table I gives formulas for section properties, direct stress, bending stress, and shear stress. If additional formulas are desired they can be readily derived in a like manner. When dealing with torsional stresses and strains, it should be remembered that the shearing modulus of elasticity should be used in place of the bending modulus of elasticity.

TYPICAL EXAMPLE. Compute the elastic limit bending moment capacity of the reinforced plastic bar shown in Fig. 2 according to the preceding derived equations, and according to the incorrect assumption mentioned in the first paragraph of this article. In that manner it will be possible to demonstrate, (*a*) the actual increase in strength contributed by the reinforcement, (*b*) that the reinforcement can reach its elastic limit before the plastic, and (*c*) that computing the strength of a composite structure by

the sum of the parts is not a valid method.

I of solid plastic bar is

$$\frac{0.5 \times (0.375)^3}{12} = 0.002196$$

I of steel insert is

$$\frac{0.25 \times (0.1875)^3}{12} = 0.000137$$

I of plastic surrounding steel insert is

$$0.002196 - 0.000137 = 0.002059$$

Assume that the steel has a modulus of elasticity E in bending equal to 28,000,000 lb. per sq. in., and that the fiber stress f_b at the elastic limit is 30,000 lb. per sq. in. For the plastic, assume that its modulus of elasticity E in bending is 1,000,000 lb. per sq. in., and its fiber stress f_b at the elastic limit is 3,000 lb. per sq. in.

Then

$\Sigma(EI)$ of reinforced bar

$$= 0.000137 \times 28{,}000{,}000 + 0.002059 \times 1{,}000{,}000$$
$$= 3{,}841 + 2{,}059 = 5{,}900$$

$\Sigma(EI)$ of solid plastic bar

$$= 0.002196 \times 1{,}000{,}000 = 2{,}196$$

$$M = \frac{f_{bp}\,\Sigma\,(EI)}{E_p\,y}$$

The actual moment capacity of the reinforced bar based on the elastic limit of the plastic material, where y equals u, equals 0.375 divided by 2, is

$$M = \frac{3{,}000 \times 5{,}900}{0{,}1875 \times 1{,}000{,}000} = 94 \text{ in. lb.}$$

Based on the elastic limit of the steel, where y equals 0.1875 divided by 2, the actual moment capacity of the reinforced bar is

$$M = \frac{30{,}000 \times 5{,}900}{0.0937 \times 28{,}000{,}000} = 67 \text{ in. lb.}$$

The actual moment capacity of the solid plastic at the elastic limit of the plastic would be

$$M = \frac{3{,}000 \times 2{,}196}{0.1875 \times 1{,}000{,}000} = 35 \text{ in. lb.}$$

If the strength of the reinforced bar was erroneously assumed to be equal to the sum of the independent strengths of the plastic and the reinforcement, an incorrect answer would be obtained, thus

Moment capacity of plastic

$$M = \frac{f_b I}{u} = \frac{3{,}000 \times 0.002059}{0.1875} = 33 \text{ in lb.}$$

Moment capacity of reinforcement

$$M = \frac{f_b I}{u} = \frac{30{,}000 \times 0.000137}{0.0937} = 44 \text{ in. lb.}$$

Moment capacity of plastic plus reinforcement is

$$33 + 44 = 77 \text{ in. lb.}$$

From these computations it can be seen that the solid plastic bar has an actual load capacity of 35 in. lb. while the reinforced bar has an actual capacity of 67 in. lb. It has also been demonstrated that the method of computing the strength by the sum of the parts is not valid, and that the reinforced bar would appear to have a strength of 77 in. lb. while it has been shown that its actual strength is only 67 in. lb. In addition, it will be noticed that in the case of the reinforced bar, the reinforcement is more critically stressed than the plastic, as it reaches its elastic limit at a moment of 67 in. lb., while the plastic is not stressed to the elastic limit until a moment of 94 in. lb. has been reached.

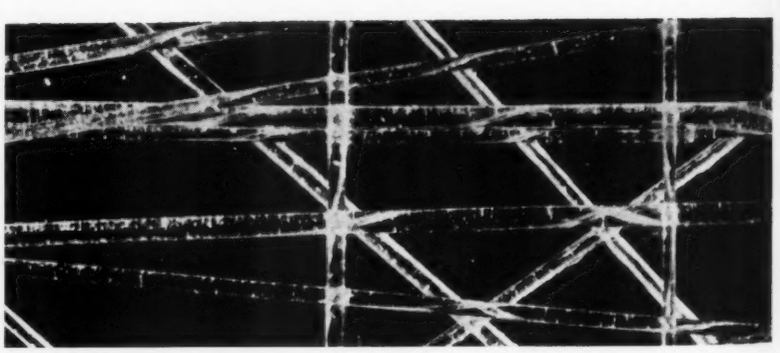
When designing composite structures the maximum stresses in each material should be computed in order to avoid the possibility of one of the components being stressed far beyond its elastic limit. By proper use of the foregoing equations, and by proper selection of materials, it is possible to design a composite structure in which all the elements reach their elastic limit simultaneously, and thereby operate at maximum efficiency.

Glass Fibers Serve As Reinforcement Agent

SEVEN BASIC TYPES OF GLASS FIBERS are available now as raw materials for use with other fibers, plastics and cement. They are also employed in various types of industrial applications and chemical process equipment.

Glass fibers are combined with plastics to serve as reinforcement for lightweight, high-strength structural parts for aircraft. The glass fibers and plastic parts can be molded at low pressures, reducing fabrication costs and man-hours. Experience indicates, according to the Owens-Corning Fiberglas Corporation, the adaptability of the fibers to similar use as reinforcement for cements and plaster-like materials where high tensile strength improves physical properties of the finished product. Filtering of air or gases, liquids and sludges by the straining method is cited as a potential field of use.

The seven basic glass fibers are distinguished by differences in fiber diameter, tensile strength and the glass compositions employed. Four glass compositions are used to provide different properties including resistance to acids and weak alkalis, to high temperatures, and to severe weathering exposure.



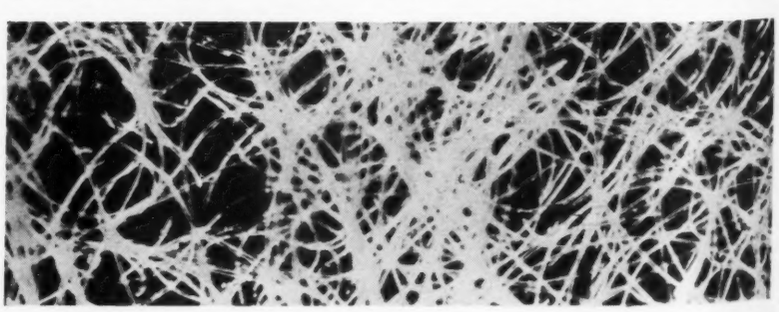
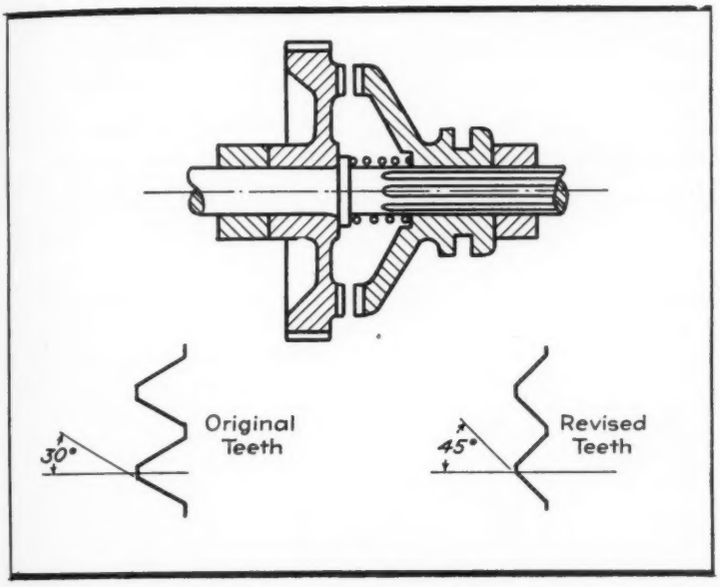
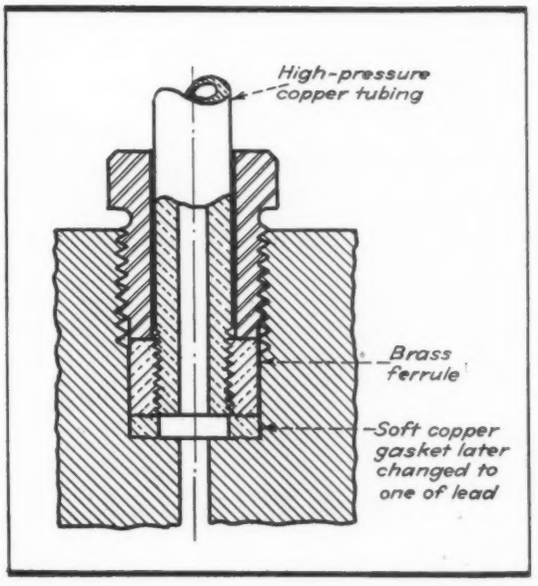


Photo-micrographs of glass fibers. Above are glass fibers suitable for filtering, evaporating and contact mat applications where low resistance is required. The glass fibers below are characterized by their "curly" nature. Each fiber is crinkled throughout its length to provide low density and high resiliency.

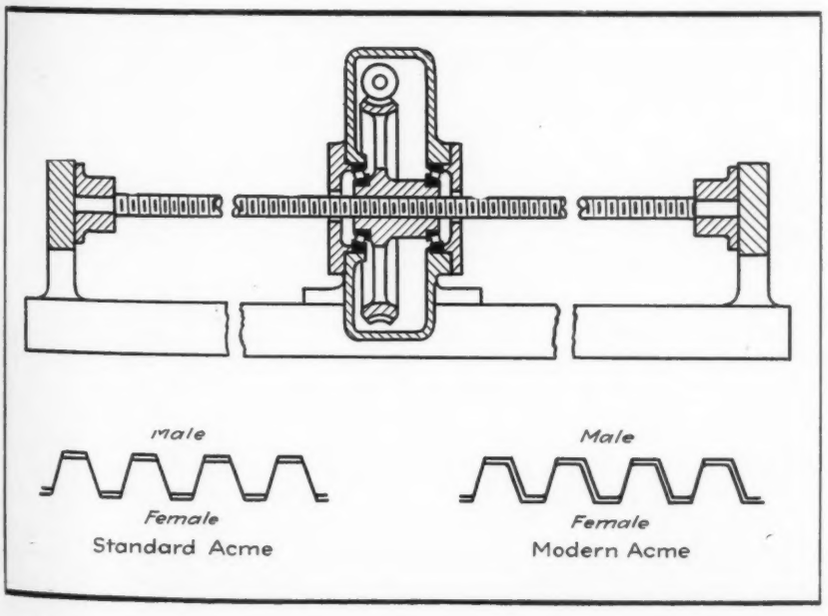
CAUSES AND CURES



Toothed clutch locking caused by friction torque was corrected by increasing tooth angle. Light radial-tooth clutch with spring release was orginally made with 60 deg. included tooth angle. Force required to separate the teeth when driving was much more than anticipated, and greater than the capacity of any spring that could be fitted into the space available. The design was corrected by recutting the teeth on the same pitch but with a 90 deg. included angle. This change in the contact angle of the teeth reduced the friction torque so that the clutch halves separated easily.



Assembly for connecting copper tubing to a steel valve block was made as shown by screwing and brazing a brass ferrule onto the end of high-pressure copper tubing. Because soft copper works excellently in contact with steel, the first gasket tried was made of soft copper. It was found that the brass ferrule was too soft to engage the copper, and that leakage resulted. All leakage was eliminated when a lead gasket was used.



Binding of Acme threads. Long horizontal power screw was fixed in position while the nut was rotated on it by power to traverse the mechanism. The nut had to be mounted in bearings, therefore, it could not float to compensate for deflection of the screw and part of the weight of the screw was supported by the nut. With standard Acme thread as first used, this load came on the taper of the threads and binding resulted. A new nut was made with a modified Acme thread as shown. Running clearance only was allowed on the O.D. of the thread, but the lateral clearance was increased. Hence the weight of the screw was carried by the flats on outside diameter.

Testing Aluminum Parts For Working Temperatures

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A detailed explanation of the technique for determining by hardness tests the temperature to which aluminum parts have been exposed in service. The method enables the designer to improve temperature conditions and determine the highest usable working stresses. It is applicable to any machine subject to high operation temperatures. This article further supplements the review of improved testing methods for complete stress analysis of machines.

IN the design of machine parts that operate at elevated temperatures, as in engines, it is highly desirable to know something about the working temperatures of the metal parts. This information will be useful to the designer in his efforts to improve heat flow conditions for cooling and will also help in determining the highest usable working stresses.

The use of thermocouples or other conventional methods have not been found feasible for measuring the temperatures reached in rapidly moving parts such as connecting rods and pistons. There are difficulties in placing and connecting the thermocouples, often practically prohibiting their use, and their presence may interfere with the normal functioning of the part. It was, therefore, necessary to develop a new method for determining the temperatures throughout the metal. One solution of the problem was to find a correlation between the temperatures to which the material had been subjected and the change in some measurable property of the material. Research engineers working on aluminum found the solution of the problem in the relationship between the hardness of a given aluminum alloy and the length of time that it has been subjected to a given temperature.

This method of determining working temperature is limited to aluminum alloys which are susceptible to heat-treatment and which, on reheating, show substantial changes in Brinell hardness. Wrought aluminum alloys 32S and 18S together with cast alloy 142 are admirably suited for estimating the working temperature of internal combustion engine parts.

Over a period of 20 years in the Aluminum Research Laboratories, data from time-temperature-hardness tests on various aluminum alloys have been accumulated. Test specimens were made from selected specific alloys that had been given controlled

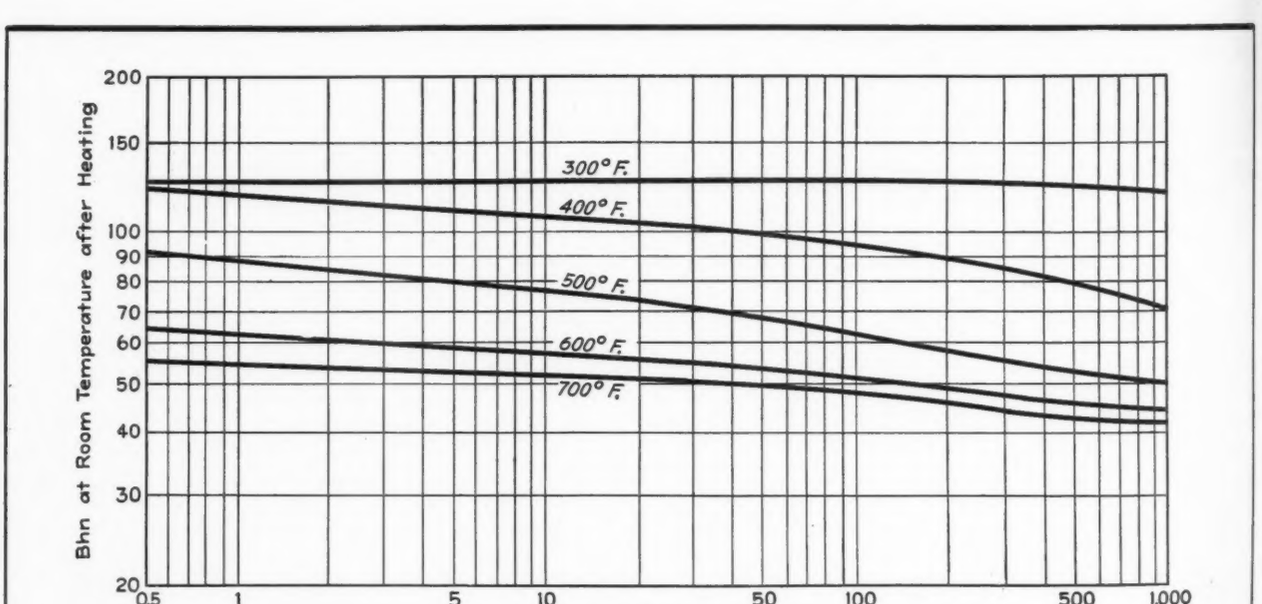


Fig. 1—Time-temperature-hardness curves obtained from a 32S-T alloy forged slab plotted to log-log scales.

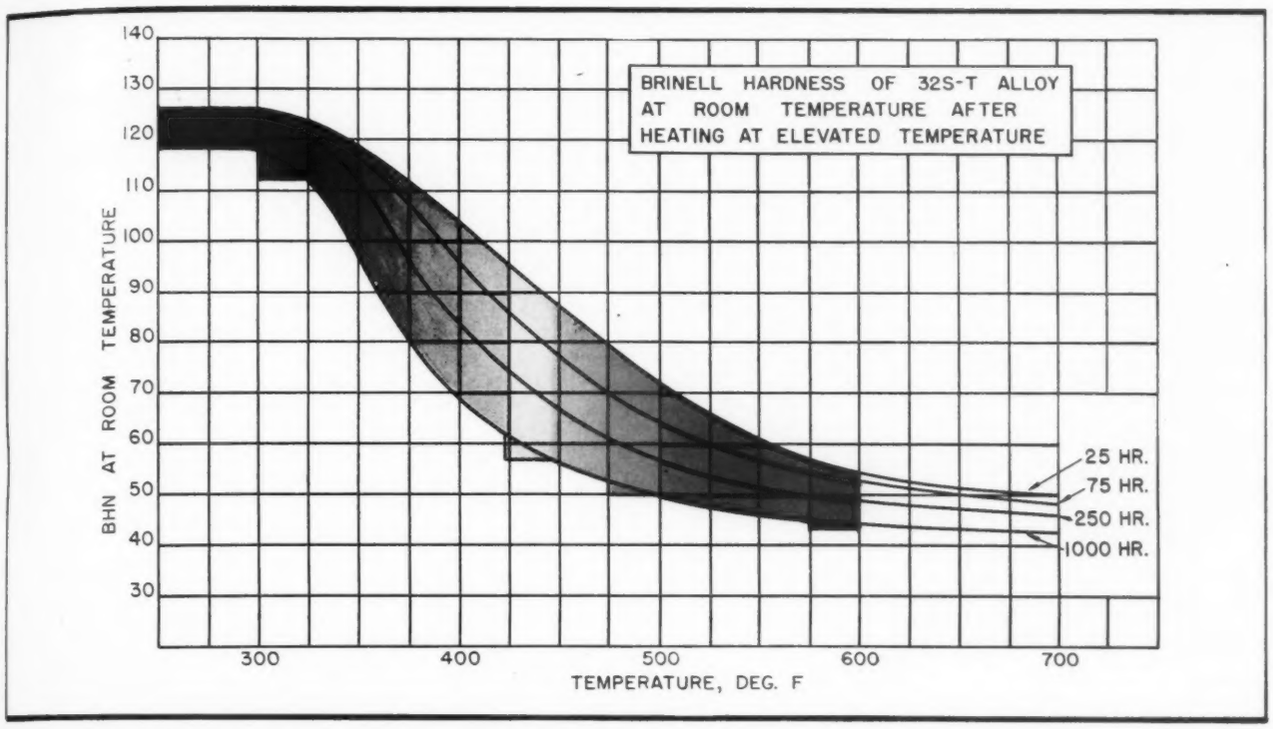


Fig. 2—Here the color designations for working temperature are applied to time-temperature-hardness curves.

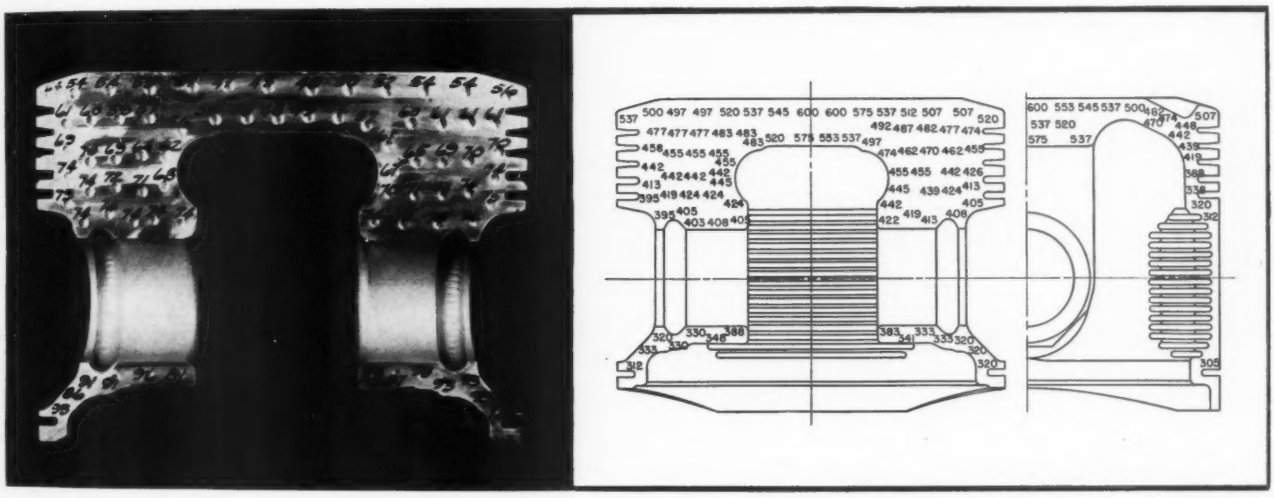


Fig. 3—(Left) Cross-section of an aluminum alloy piston for which Brinell hardness numbers have been determined.
Fig. 4—(Right) Cross-section of a piston with Brinell hardness numbers converted to working temperatures.

processing and heat-treatment. These specimens were then held at various selected elevated temperatures which were held constant. At stated intervals specimens were allowed to cool to room temperature and Brinell hardness readings taken on them.

From these data, for each aluminum alloy, there was plotted a family of curves, one curve for each elevated temperature. The ordinates of these curves are Brinell hardness numbers and the abscissas are time. Fig. 1 is an example of such curves for a forged aluminum alloy. They are usually plotted on log-log paper on separate sheets for each alloy. To facilitate interpolation, these data are sometimes plotted as shown in Fig. 2 with temperature as abscissas.

With complete curves of hardness versus temperature and time, it is relatively simple to determine the equivalent working temperature to which a given part has been subjected if the period of operation is accurately known. Take for example the investigation of a piston in an aircraft engine. With the piston made of a specific aluminum alloy and of specified and controlled fabrication and heat-treatment, the engine is assembled in the usual manner and run at maximum horsepower for a given time, usually about 10 hours or more. It is important that the engine be operated at constant maximum output. Upon completion of the test run, the engine is allowed to cool and is then disassembled.

If the working temperatures to which the piston has been heated are to be investigated completely, the piston is cut into a number of sections. These are usually two longitudinal sections perpendicular to each other, one passing through the center line of the wristpin. For diesel en-

gines, special attention is given to that section of the piston where it meets the injection spray. Care must be exercised when sectioning the piston, to make certain that the metal is not heated to a high temperature during the cutting. This is relatively easy to control. The sectioned surfaces are then machined to an accurate finish.

Brinell readings are taken on the sectioned surfaces; the measurements are best taken at points about 3/8 in. apart. In general, the harder the surface the closer may be the points. As most of the Brinell readings are under 100, a 10 mm. steel ball is used under a 500 kg. load. Where the readings are above 100, a 1/16 in. dia. ball under 1,000 kg. load is used.

The Brinell impression should be measured across two diameters at right angles and the average taken of the two readings. If the measurement across one axis is 3.4 mm., and the other axis measures 3.2 mm., the average of 3.3 mm. is taken as the true reading. However, if proper care is exercised, irregular impressions are rare.

In Fig. 3 is shown a typical cross-section of an aluminum alloy piston on which the hardness numbers have been determined. By referring to curves such as shown in Fig. 1, the Brinell hardness numbers can be converted to working temperatures in Fahrenheit degrees. When the hardness values are converted into temperatures, the designer or stress analyst has available information on the working temperatures of the metal throughout the piston. The temperature data can be shown graphically as indicated by Fig. 4. These data are useful in the selection of allowable working or design stresses for that particular piston. The information is also valuable in a study of the design for the purpose of improving the conditions of heat flow through the piston. Possible hot-spots in the piston face, which may cause premature ignition, might also be discovered and eliminated.

In the application of this method, consideration must be given to the accuracy of the Brinell hardness determination and to unavoidable variations in the composition and structure of the material. It should be possible to estimate working temperatures on a given part with a precision or reproductivity of plus or minus 25 deg. F. The over-all accuracy may be somewhat less. The precision will be governed somewhat by the combination of time and temperature, being greater at some points of the curves than at others. Further, by making measurements upon several similar pistons subjected to the same conditions, the average of the results from each will improve the precision of the determination.

The multitude of numbers shown in Fig. 4 make it difficult to trace the temperature gradients and determine the lines of heat-flow. It also creates confusion when attempting to compare the heat-flow conditions in two different designs.

In order to avoid this confusion, temperature-color charts were developed for pictorializing the temperature conditions throughout the piston. Using the basic spectrum for representing color, solid dark blue was selected for the range of temperatures from room temperature up to 300 deg. F. The accompanying table shows the color designation for the various temperature ranges up to 600 deg. F. or more.

Color Designation for Different Working Temperatures

Room temperature to 300 deg. F.	Solid Dark Blue
300-325 deg. F.	Solid Light Blue
325-420 deg. F.	Blend Blue to Yellow through Green
420-440 deg. F.	Solid Yellow
440-475 deg. F.	Yellow to Orange
475-500 deg. F.	Solid Orange
500-575 deg. F.	Orange to Red
575-600 deg. F. or more	Solid Red

In Fig. 2 is shown the application of these color designations to the time-temperature-hardness curves. In Fig. 5 is shown an example of the use of color pictorialization as applied to the temperatures in an aluminum piston. Fig. 6 shows the same tech-

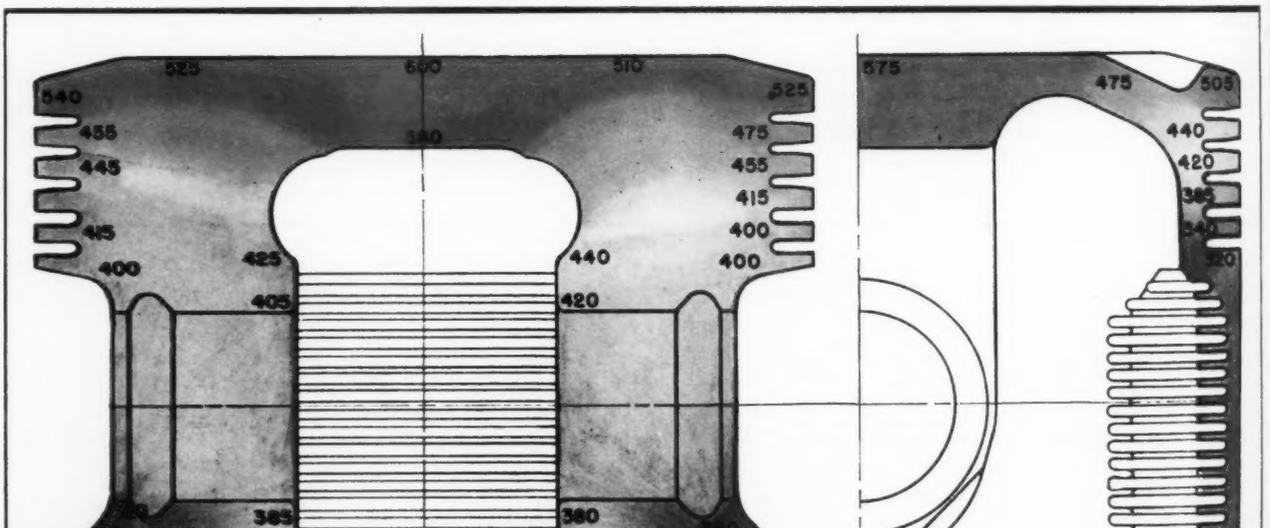


Fig. 5—Working temperatures shown in color across sections of a piston used in an engine in civilian air line service.

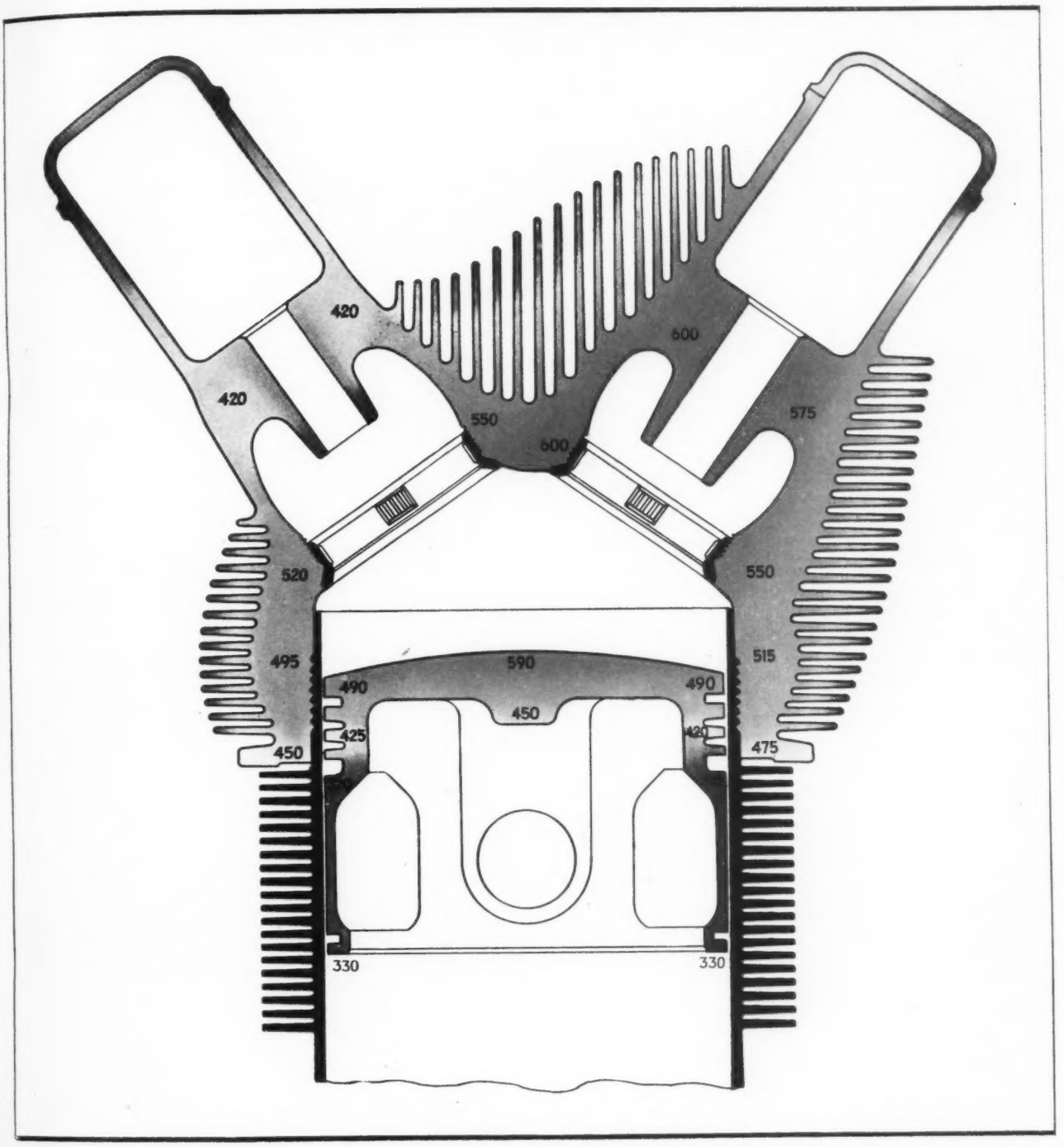


Fig. 6—Color designations for working temperature applied to the cross-section of a cylinder head piston assembly.

nique applied to a cylinder head piston assembly.

The color at any point indicates the temperature, the change of color from solid red toward blue indicates the paths of heat flow. One can readily visualize the numerous design possibilities through the use of these temperature charts. Hot-spots may be eliminated through a modifying distribution of the metal or better cooling, or through a copious supply of oil. Or it may be discovered that what was formerly considered a failure through overload or weak material was actually a failure caused by an excessive working temperature.

In a similar manner, it is simple to determine the working temperatures to which forged aluminum connecting rods in engines are subjected. The objective here would be to determine the highest possible working stress that might be used and to investigate the possibility of decreasing the temperature of the rod through better cooling by the lubricating oil.

Although this temperature-measuring technique has found its greatest application in the development of superior designs for aircraft engines, the fundamental principles have possible applications in many other types of investigations. In any machine where high operating temperatures are involved, and the parts are made of heat-treatable aluminum alloy, this technique of temperature measurement can be employed.

HOW TO DIMENSION PERSPECTIVE DR

Perspective drawings are now in general use by aircraft companies and other firms are becoming increasingly interested in their use. This review of the principles of dimensioning perspective drawings is based on the practices of Fleetwings Division of Kaiser Cargo, Inc.

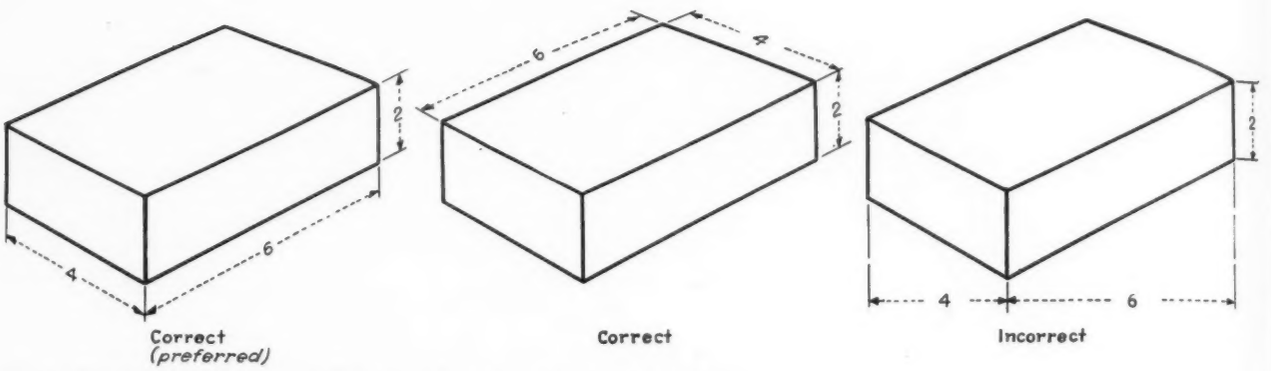


Fig. 1—Extension and dimension lines must be drawn in perspective. Extension lines should be drawn in the plane of the surface to which they apply. Dimension lines must appear parallel to the direction of the measurement.

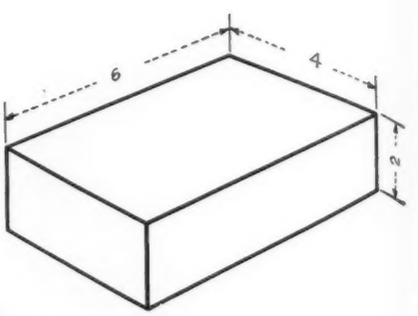


Fig. 2—Dimensions should apply to visible surfaces, if possible, but the practice shown above is permissible if it is unavoidable.

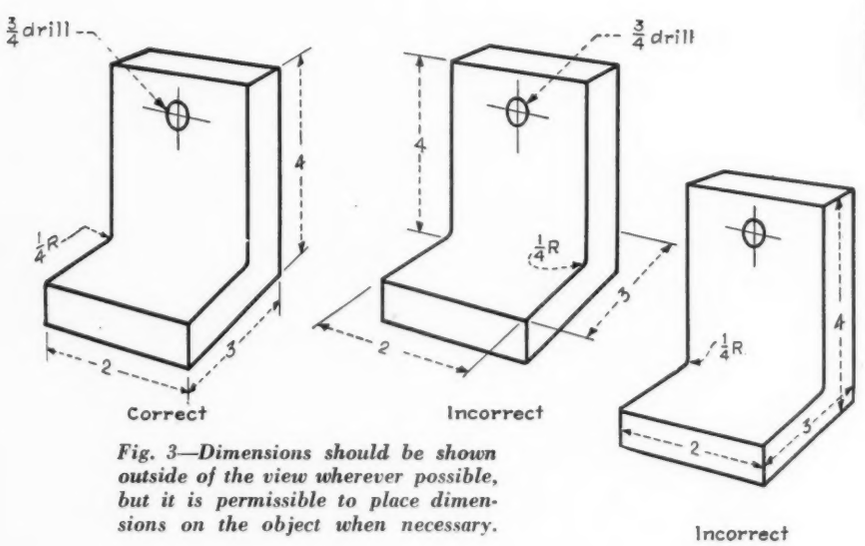


Fig. 3—Dimensions should be shown outside of the view wherever possible, but it is permissible to place dimensions on the object when necessary.

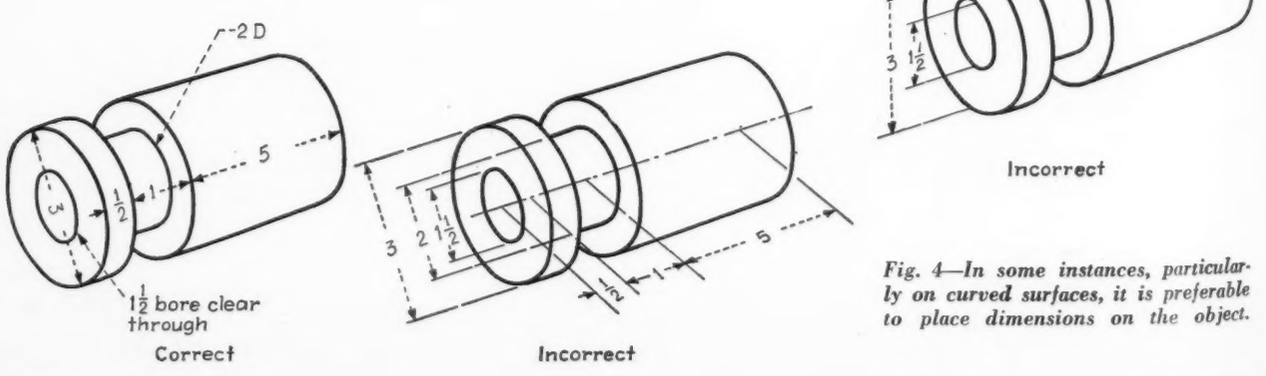


Fig. 4—In some instances, particularly on curved surfaces, it is preferable to place dimensions on the object.

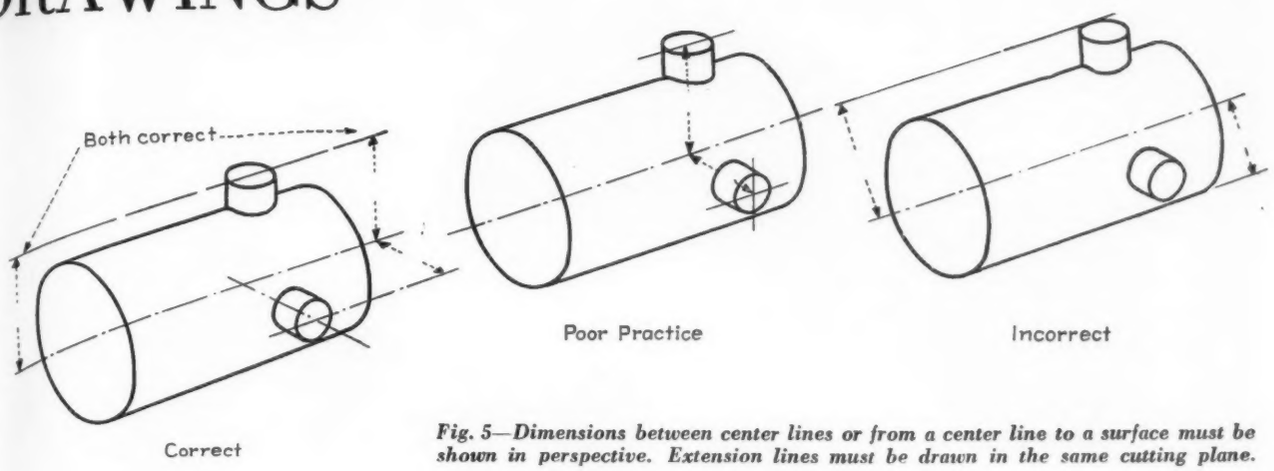
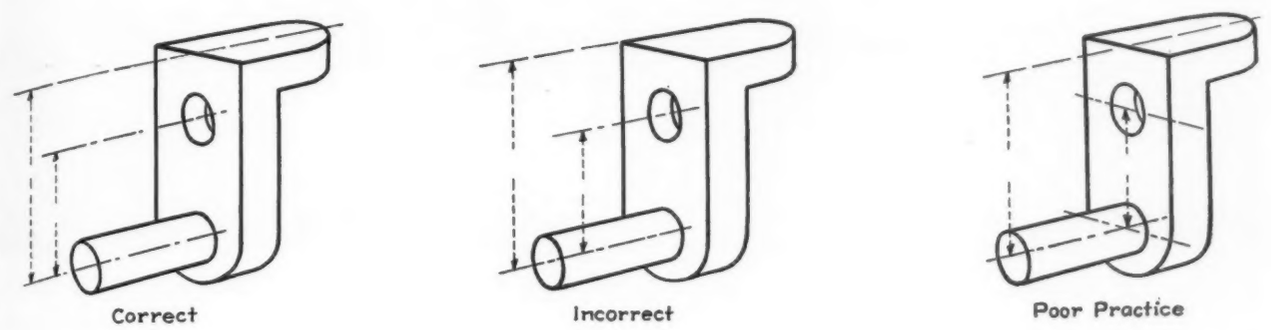
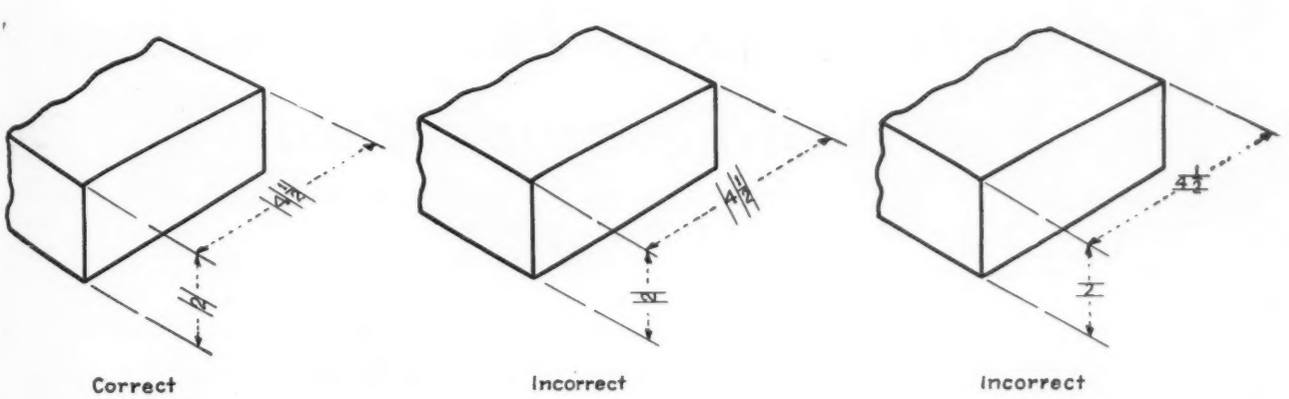


Fig. 5—Dimensions between center lines or from a center line to a surface must be shown in perspective. Extension lines must be drawn in the same cutting plane.





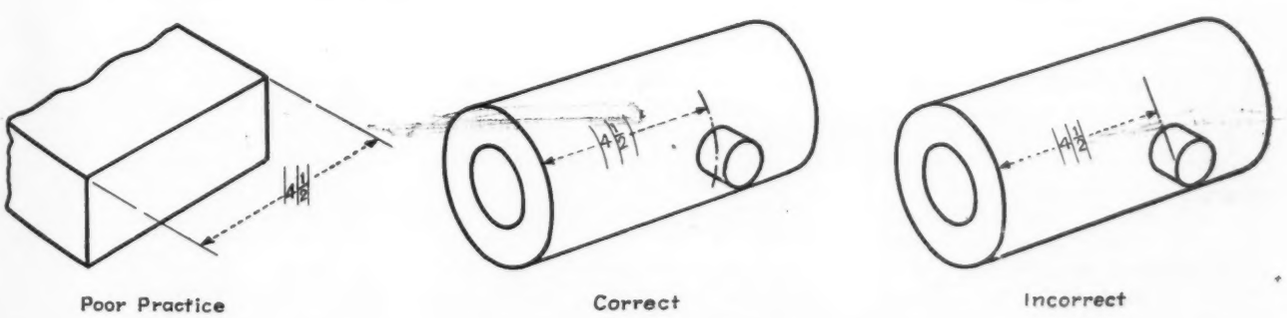


Fig. 6—Numerals and arrowheads should be drawn in perspective. Guide lines for numerals should appear parallel to the corresponding perspective plane. Numerals and arrowheads on curved surfaces should follow the contour of the surface. Arrowheads should appear parallel to the respective perspective plane. Notes need not be lettered in perspective but it is preferred that vertical rather than inclined lettering be used.

Bronze anti-aircraft gun parts blackened with cupric oxide for reduced reflectivity and protection against weathering.

Characteristics of Black Coatings For Non-Ferrous Metals

WALTER R. MEYER
Technical Director, Enthone Company

Four general types of black coatings which can be applied to non-ferrous metals are described. The coatings are analyzed from the standpoint of distinctive characteristics, and various application methods are described.

WEAR-RESISTING qualities are prime requisites of Army and Navy equipment during wartime. For this reason, protective black coatings for non-ferrous metals have attracted the attention of design engineers. There are four general classes of black finishes—oxide, metal complexes, sulphide and telluride, and metallic. Characteristics of the first have been found superior to the other three for some applications.

Black-oxide coatings are generally characterized by excellent adhesion, good corrosion protection, temperature stability, deep blackness, and are a good base for organic finishes. Their thickness is usually from 0.00002 in. to 0.00005 in., but in certain instances thicknesses of 0.0005 in. may be reached.

Consisting of black nickel and black chromium, metal complex finishes can be deposited to heavy thicknesses, up to 0.001 in., with good wear resistance. Black-chromium coatings withstand temperatures to 800 deg. F. and can be used in partial vacuums.

Sulphide finishes are applied more easily than oxide finishes, but may be generally inferior in all properties. Adhesion and ductility are poor. The coatings are chemically unstable and offer little or no protection to the base metal (E. S. Hedges, "Protective Films on Metals," D. Van Nostrand Co., 1932, p. 84). These finishes also have low heat stability. Their thickness is about the same as that of oxide finishes.

Metallic finishes are the so-called metallic smuts and are, as the name

implies, smut deposits formed by chemical replacement of a metal in a solution by the basis metal. Arsenic and antimony are applied as smuts.

Black-Oxide Coatings

This class of coating can be subdivided into methods of application. These are direct chemical oxidation at low temperatures, direct oxidation at high temperatures, electrolytic oxidation, anodic deposition, chemical reduction from a higher valence state and chemical precipitation.

Direct chemical oxidation of copper and its alloys at low temperatures has just recently reached wide commercial use. The process produces the most satisfactory black finish of any method, considering all properties. It utilizes aqueous solutions of strong oxidizing agents in the 150-250 deg. F. temperature range.

Copper and its alloys can be oxidized directly to cupric oxide, producing a chemically-stable coating with exceptional adherence properties. This coating, when oiled, protects copper against salt spray up to 200 hr., and when no oil is applied provides protection for about 20 hr. Unblackened copper or copper alloys develop green corrosion products in a fraction of the time when exposed to salt spray. The finish is widely used on marine equipment made of copper, brass and bronze, such as antennas, binnacles and marine hardware because of its salt-spray resistance.

The high adhesion and ductility of cupric-oxide coatings have made them useful for blackening copper objects which must be deformed, such as grommets. The coatings have a dull, velvety appearance that produces a nearly perfect optical black, which accounts for their use on optical instruments. If desired, the velvet can be laid over and higher gloss finishes obtained.

Cupric-oxide coatings have heat radiation and heat stability characteristics of definite advantage for heat-radiating apparatus. The finish also is used on certain high-purity copper parts of electronic power tubes and makes an excellent base for finishing copper alloys with paints, enamels and lacquers. Before development of this finish, there was no entirely satisfactory method of treating copper alloys for painting.

Any metal capable of being copper plated can be given a cupric-oxide finish by copper plating and oxidizing. This technique is rapidly replacing black-nickel plating because of the much greater ease of the process over black nickel and because of the greater depth of color and adhesion of the cupric-oxide finishes. Cupric-oxide finishes cannot be satisfactorily applied directly on alloys with less than 65 percent copper. However, there is no other direct method for blackening such alloys and a plating operation is therefore necessary.

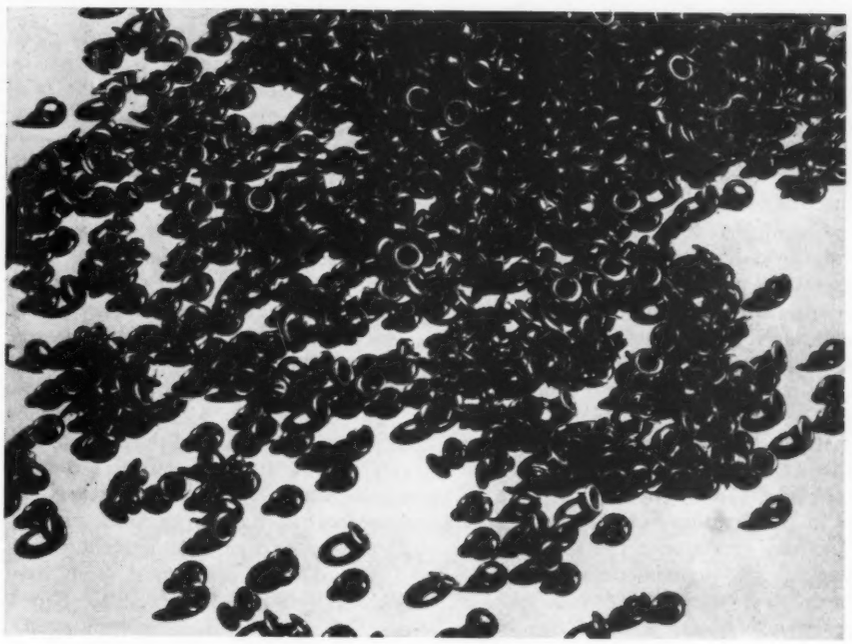
Most blackening of nickel has been done by depositing some other metal on the nickel and blackening that metal, or by a black-nickel plating process. An interesting method of blackening nickel has been described by B. B. Knapp in a patent assigned to the International Nickel Co. (U. S. Patent No. 2,221,641, Nov. 12, 1940). The method requires the use of an oxidizing agent, such as hydrogen peroxide or ammonium persulphate, together with a substance that forms small amounts of sulphide ions in solution, such as ammonium thiocyanate, and the bath is operated in a low pH range from 1 to 2. It is not clear whether the finishes obtained are sulphides, oxides or mixtures of these substances.

Direct oxidation at high temperatures is one of the oldest methods for producing black-oxide coatings. When copper is heated in air or oxygen up to 800 deg. F. and over, heavy coatings are formed consisting of an outer layer of smooth, black cupric oxide and an inner layer of red cuprous oxide (U. R. Evans, "Metallic Corrosion, Passivity and Protection," Edward Arnold & Co., 1937, p. 98). The method, however, is not used frequently for blackening copper. Cuprous-oxide coatings are applied to copper in fused nitrate baths but the coatings are red, not black.

A method once extensively used for putting a gray-black finish on copper and its alloys involves immersing the copper or alloy in a copper nitrate solution acidified with nitric acid and then heating the work. The finish produced is not very attractive and is applied to small articles. Low-temperature chemical oxidation is replacing this method.

Electrolytic oxidation of aluminum and zinc has grown in popularity because of the war. Aluminum and its alloys can be oxidized by anodic treatment in sulphuric acid, chromic acid and other electrolytes and the coatings thus formed can be dyed and sealed. (The "Alumilite Process." Patents held by the Aluminum Company of America, Pittsburgh, Pa.). Usually sulphuric acid solutions are used because heavy oxide coatings of the order of 0.0001 in. –0.003 in. are formed and can be dyed easily in almost any color.

An interesting method that the writer observed in Germany before the war involved oxidation of aluminum. The oxide was impregnated with a silver emulsion and the surface was then sensitized, using it in the manner of photographic print paper. Any pattern could be reproduced upon the



Zinc grommets blackened with molybdenum sesquioxide

aluminum. Wall paneling can be made to reproduce marble or wood so that the reproduction can be detected only on very close inspection. Nameplates can be made with a fineness of detail impossible to obtain with other methods. Etchings and paintings can be perfectly reproduced upon the aluminum with the reduced silver protected by the hard, clear, aluminum-oxide coating. This method may reach considerable importance after the war when aluminum is freely available.

Zinc-base die castings can be darkened by making them the anode in a dilute sodium hydroxide solution. Zinc and zinc alloys are blackened by molybdate solutions and by nickel-ammonium thiocyanate solutions.

Anodic deposition has not been developed to a successful commercial scale. Methods for depositing lead-peroxide coatings by making the work the anode in sodium plumbite solutions have been described in technical literature but the adhesion of the coatings is not good. Thallium oxide can also be deposited upon the anode but the process is still of academic interest only.

Chemical reduction from the higher valence state is highly successful commercially in the case of molybdenum sesquioxide coatings for blackening zinc and zinc alloys. Electroplated zinc, hot galvanized coatings, rolled zinc, and zinc-base die castings can all be blackened satisfactorily. The method involves proper cleaning of the work and placing it in buffered molybdate solutions operated from room temperature to the boiling point. The zinc reacts with the solution, reducing the molybdenum from the hexavalent state in solution to the sesquivalent state which forms as an adherent, smooth, black coating upon the surface. The coatings range in thickness from 0.00002 in. to 0.00005 in. Heavy deposits are not ductile but properly applied coatings withstand moderate deformation. Little zinc, of the order of 0.00003 in., is dissolved during the blackening and the process has little influence on the corrosion qualities of the zinc surface. The coatings are good bases for organic finishing.

An electrolytic method is available commercially that co-deposits nickel and molybdenum oxide by electrolytic reduction from soluble molybdates. The adhesion of such deposits is not good on all basic metals but they adhere particularly well to zinc.

A method very widely used for depositing a blue-black oxide coating on brass is the so-called "copper carbonate-ammonia" method. (For more detailed discussion see "Blackening of Non-Ferrous Metals," by Walter R. Meyer, *Transactions*, Annual Convention, American Electroplaters' Society, June, 1943). The bath utilizes basic copper carbonate to which ammonia has been added to form a soluble blue complex. The ammonia must not be in excess and this is assured by having an excess of copper carbonate present. The carbonate is not essential to the process inasmuch as other copper salts, such as copper sulphate, can be used satisfactorily. The process is good for depositing a blue-black color on brasses containing from 65 to 80 percent copper. Low-copper alloys do not react satisfactorily and high-copper alloys give a gray-colored deposit. Low-copper brasses, such as 60:40 brasses are best blackened by copper plating and then blackening the copper by direct oxidation.

The corrosion protection afforded by this type of coating is not good, being of the order of 2 hr. in the salt spray. However, when corrosion protection is not a factor, the copper carbonate process is a cheap, easy method for blackening brasses.

Metal Complexes

Black-nickel coatings are gray-black deposits and have been used for many years, particularly on typewriter parts. The coatings are deposited from solutions containing nickel, zinc, the thiocyanate radical and the ammonium radical. A typical analysis of the coating is sulphur, 8 percent; NH_3, 4 percent; carbon, 4.5 percent; nickel, 23 percent and zinc, 48 percent.

The coatings are almost structureless and have only fair ductility. However, when the solutions are run properly thick deposits of the order of 0.001 in. can be formed. The corrosion protection offered is poor and protection must be obtained by an undercoating, normally nickel plating. Iron and copper are poor bases for the deposition of black nickel.

Black nickel is not a good base for baked organic finishes. When heated to about 350 deg. F. there is a sudden evolution of ammonia and at higher temperatures water and sulphur-containing compounds are driven off. Another drawback to the use of black nickel is that considerable technical skill and care are necessary to maintain and operate the solutions with satisfaction.

Black-nickel solutions are used to a limited extent for depositing a black coating on zinc surfaces without the use of electric current. Such solutions are not good for electroplated zinc because the zinc plate is appreciably dissolved during the treatment and there is formation of white basic zinc salts that adhere to the finish.

Sulphide Coatings

Black-sulphide coatings on non-ferrous metals are easy to apply. They are formed on copper and silver by immersion in dilute sulphide solutions. When care is used in their formation, such as proper surface preparation and slow formation, black coatings can be formed that have fair adhesion, but severe deformation will cause heavy deposits to flake. They offer little or no corrosion protection to the base copper and are not good bases for baked organic finishes. Also, they are prone to "crystal spotting."

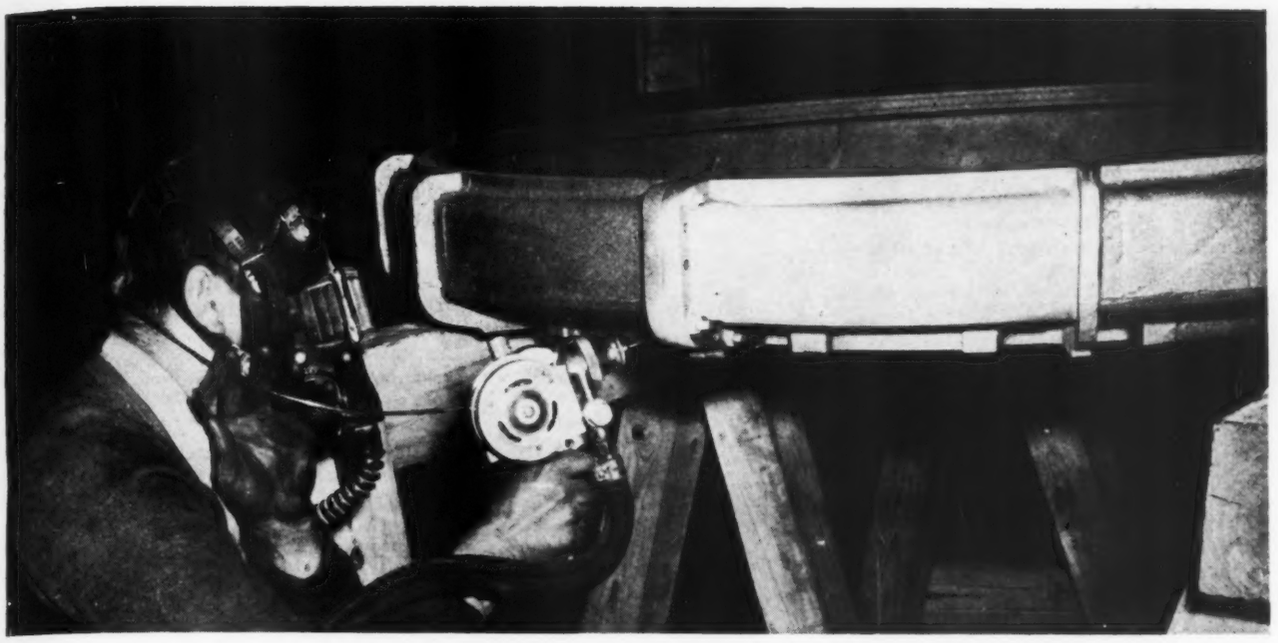
More stable and adherent black coatings are formed on silver and gold by heating and decomposing tellurium chloride solutions which leave a deposit of tellurium and silver telluride on silver and probably just tellurium on gold. This type of deposit has replaced, to a large degree, platinum blacks on silver and gold formed by decomposing platinum chloride.

A method of blackening aluminum by the use of selenium has been patented by W. A. Fuller (U. S. Patent No. 2,303,350, Dec. 1, 1942). The process involves immersing the aluminum in a solution containing ". . a mixture of selenium compound which produces selenous acid, and a soluble halogen salt of copper."

Metallic Black Coatings

Smut-type black deposits can be formed on zinc, cadmium and iron by using acidified solutions of arsenic or antimony. However, the deposits have poor adhesion and cohesion, and in the case of arsenic there is danger of poisonous arsine formation. Besides, arsenic-coated metal is a health hazard. In addition, the formation of such deposits on plated coatings results in attack on the coating by the acid in the blackening solution.

Black chromium coatings have been electroplated for about ten years to a limited extent, particularly where the part must withstand high temperatures. The deposits are probably mixtures of metallic chromium and chromium oxides. Chief drawback associated with these coatings is the high current density required, namely above 1,000 amp. per sq. ft. Low temperatures must be maintained during plating and the high-current densities cause such heating that artificial refrigeration is required for any large-scale plating.



Cast iron gear shroud for Bofors "Twin" anti-aircraft gun is zinc-coated for corrosion protection.

Production Metal Spraying Offers Economies in Design

Principal wartime applications of metallizing embrace conservation of critical metals. Advantageous new applications for small and large-scale production are described to indicate the possibilities of this surface-coating method for post-war design. Most of the examples and illustrations are experience records of Metallizing Engineering Company.

WIDE application of the metal-spraying process as a maintenance and repair tool has somewhat eclipsed the possibilities of metallizing as a production process. But the production possibilities of metal spraying, based on present experiences, merit the consideration of design engineers. In addition to conserving critical metals, the process enables inexpensive materials to be equipped with properties ordinarily requiring expensive alloys for a whole part.

Metallizing is accomplished by means of a compact, easily-handled gun. Generally the desired metal is in wire form, which is fed into the gun continuously and passes through a flame cone where it is reduced to a molten state. As the metal melts, it is atomized by an air blast, which then drives the molten particles at high velocity against the surface to be coated. The guns are generally operated manually, but provision is often made in production work for mounting the gun in a fixed or movable position to spray objects moving in front of it.

Metal spraying can replace tinning, galvanizing, calorizing, electroplating, and welding under certain conditions. Parts of any size can be metallized, providing they are of a shape that can be reached by the gun. The types of metal used for metallizing are shown in Table I. All metals except chromium and hard-surfacing materials such as Stellite can be put on in wire form. Coatings of any thickness can be applied. There is no danger of heat distortion since the objects receiving the spray are cold. The metal spray is harmless to human flesh at a distance of 18 in. from the gun nozzle.

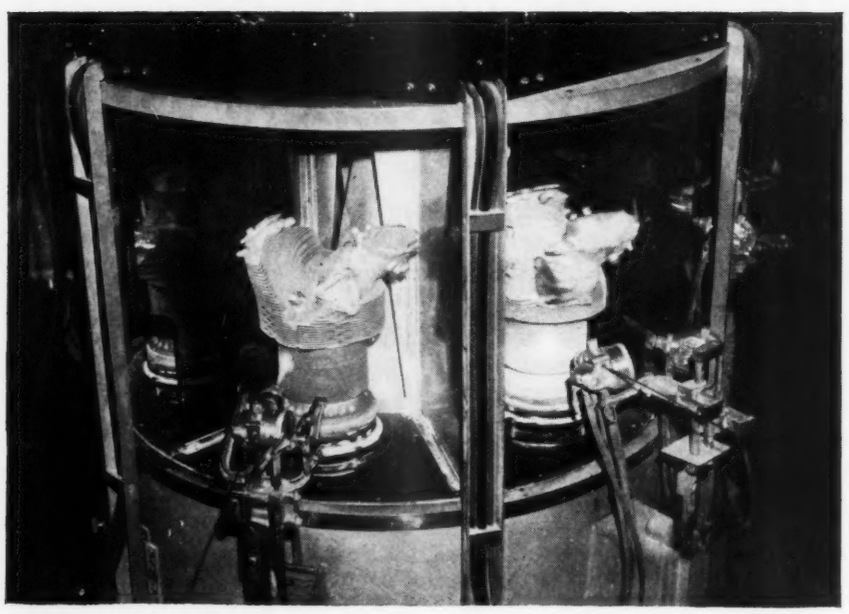
Proper surface preparation is essential to successful metallizing. This preparation generally requires roughening the base metal surface either by sand- or grit-blasting, machining, or a recently developed electrical method. Surfaces must be free of contamination. Best results are obtained usually by metallizing immediately after preparation of the surface, or within a few hours, depending upon the material to be coated. This avoids surface oxidation or other contamination of the prepared surface. Inexperienced workers can be trained quickly to become efficient metal sprayers.

Two parts of the Bofors anti-air-

Table—Metallizing Wires

Metallizing Engineering Company

Metal	Application	Rockwell Hardness
Aluminum	Commercial grade: for common corrosion work	H-72
Aluminum	High purity: To resist heat corrosion	
1% Zinc	Salt water corrosion protection of iron and ferrous alloys	
Babbitt	Tin base (lead free); for heavy duty bearings	H-58
Babbitt	Lead base: Light duty and production work where cost is a major factor	H-11
Brass	Gives good machine finish. Used to fill sand spots on brass castings	
Bronze	Soft commercial-type: Used to fill sand spots in castings	F-67, F-69
Bronze	Non-fuming type, similar to M25 bronze. Special applications	F-75, F-76
Bronze	Phosphor bronze	F-73, F-74
Bronze	Tobin-type: Most used bronze for all types of metallizing	F-78, F-79
Copper	Used largely for electrical conductivity and special work	F-78, F-79
Lead	General corrosion work where pure lead coating is required	
Lead	7-8% antimony, hard lead for special corrosion problems	
Monel		F-78, F-79
Nickel		F-86, F-88
Iron	High purity soft iron: Used for blow holes in castings, press fits, mis-machined castings	B-79, B-81
Steel	0.10 carbon: Most widely used soft steel	B-84, B-86
Steel	0.25 carbon:	B-93, B-95
Steel	0.40 carbon: Hardest machineable-sprayed steel	B-96, B-98
Steel	0.80 carbon: Hard, wear-resistant coating	C-34, C-36
Steel	1.20 carbon: Recommended only where slight additional density is required	C-30, C-32
Stainless steel	18.8: Very low carbon type having corrosion resistance and excellent wearing quality	B-78, B-80
Stainless steel	High carbon, high chrome steel: For abrasion and corrosion resistance	C-31, C-33
Tin, pure		H-10
Zinc, pure		H-46



Production metallizing set-up for airplane engine cylinders at Wright Aeronautical.

craft gun are examples of conservation of critical metals by metal spraying. One is the barrel spring recoil sleeve and the other is a gear shroud. Both the old and new designs of the sleeve were illustrated on page 468, August, 1943, PRODUCT ENGINEERING.

The recoil sleeve, originally a 16-lb. manganese bronze casting, was redesigned by Chrysler engineers in carbon steel and sprayed with 2 lb. of Tobin bronze. The saving of bronze amounts to at least 60,000 lb. per month. Tests show that the redesign is equal to the original in frictional qualities, has equivalent resistance to seizure, and has good shear strength although tensile strength is low.

The gear shroud, originally a bronze casting, is now a 280-lb. malleable iron casting sprayed with electrolytic zinc. It was redesigned by the Blaw-Knox Company.

The metallizing process is credited with saving considerable stainless steel in the shafts of centrifugal pumps manufactured by Morris Machine Works, Baldwinsville, N. Y. Because one section of the shaft is subject to corrosive action of caustic solutions, it was necessary to make the entire shaft of corrosion-resistant metal. Metallizing, however, permits the shaft to be made of low cost, easily machined carbon steel as the section requiring protection is undercut and sprayed with stainless steel.

One of the most important operations in the fabrication of smokeless gun powder cans is to replace the galvanized coating that has been removed by welding the seams. This is done by Round Oak Company, Dowagiac, Michigan, by metallizing, which, in addition to replacing the corrosion-resistant coating, is further insurance against moisture leakage if a weld should be imperfect. This type of application of metallizing has come into wide use.

The speed of handling this operation in fast production, its simplicity and efficiency, and its low cost are outstanding features of its use, according to E. S. Burch, chief engineer. One pass of the gun with a downward sweep and one pass upward completes

the metallizing operation. Coatings intended primarily for protection against corrosion are rarely machine finished since sprayed surfaces usually correspond to those of fine castings. When decorative effects are desired the coatings can be ground, polished or chemically treated to produce various colors.

Spark-proofing of powder tanks is another application of metallizing reported by the Floyd-Wells Company. Ordinarily this was accomplished by use of a bronze or aluminum casting at the mouth of the tank. The tanks are now made entirely of sheet steel. A thick bronze coating is applied to the inner and outer surface at the open end for a depth of 4¼ in. and the remainder of the body is zinc-coated. A specially engineered set-up enables multiple metallizing guns to operate simultaneously.

Alloy steel once was used for casting conveyor pans in a mid-western foundry. Now these pans are made by John Nooter Boiler Works Company, St. Louis, of mild steel and the alloy applied only to the surface for sufficient depth to satisfy heat resistance requirements of the conveyor.

Marked savings in stainless steel are realized by fabricating refrigerator trailer bodies of other metals and adding a surface-coating of zinc as shown.

Spraying speed nuts with zinc is accomplished in this production set-up at Tinnerman Products, Incorporated.

Important savings in nickel-chrome alloy are made by coating the annealing covers at a large steel fabricating and rolling mill in Pennsylvania. Previously made of 18-8 stainless, each cover required approximately 600 lb. of chromium and 240 lb. of nickel. Now they are made of carbon steel boiler plate and sprayed with 30 lb. of aluminum. While it is true that the metallized covers withstand only 96 heats as against 150 to 175 for those made of stainless, a saving of chromium and nickel has been accomplished by a reasonably satisfactory substitute.

Furnace equipment and parts can also be made of metallized carbon steel. One large company has saved 40,000 lb. of alloy steel in four months by this means.

A second class of applications for metallizing are those on which less durable base metals can be made to give much longer and more efficient service by coating with wear or corrosion-resistant metals.

Outstanding in this group of applications is the spraying of pure aluminum on aluminum alloy aircraft engine components as a protection against atmospheric corrosion. Wright Aeronautical Corporation and others are now employing fast production line equipment to do this job automatically. At the Wright plant an automatic spraying machine utilizing seven guns simultaneously sprays thin-finned cylinder heads to the full depth of the fins in 75 seconds, 8 percent of the time formerly required by manual operation of metallizing guns. Prior to the application of metallizing, these parts were given two coats of paint, both requiring baking for considerable time. Improved heat dissipation is another advantage of the change to metallizing.

While most applications of metallizing to metals in this class are intended for imparting corrosion resistance, an instance where wear resistance may be gained by metallizing

the surface of a magnesium alloy part was indicated in PRODUCT ENGINEERING, June, 1943, p. 375. Similarly, aluminum parts might be coated for wearing surfaces. One advantage of such surfacing is that they are characterized by a porosity, which retains lubricant. Sprayed coatings have much lower tensile properties, elasticity and density, than the same material in the usual solid forms, such as sheet metal of the same thickness, and are usually unsuited to extreme pressure and shock.

Innumerable examples could be cited where metallizing is employed to impart corrosion resistance. These include large tanks, which cannot be hot galvanized, heat-treating equipment such as salt and lead pots, superheater tubes and supports, oil burner caps and baffle plates, pyrometer tubes, ladles, furnace conveyors, doors, and other parts, engine exhaust manifolds, laundry drying baskets and extractors, steel tubing in aircraft fuselages, wing members, floats, fuel tanks, beaching gear, and many other parts. Aluminum or zinc are most commonly used for aircraft parts.

Speed nuts for aircraft are metallized with a 0.0005-in. coat of zinc on a large production basis by Tinnerman Products, Inc. Formerly electroplated with cadmium, it was found that carbon steel picked up free hydrogen, which caused embrittlement, and necessitated a 20-hr. baking process to release the hydrogen. Wire mesh baskets containing the nuts are rotated now and zinc is sprayed on them for 5 or 6 min. The resulting finish withstands a longer test than the former cadmium plating.

Salvaging of worn parts is a maintenance problem. Many worn parts have been put back into service after being rebuilt by metallizing. In addition, metallizing can be a production tool for recovering rejects on the production line when used to restore proper dimensions to mis-machined parts, thus minimizing the number of rejects.

Extremely close tolerances on Bofors gun base rings, which weigh 1,550 lb., gears weighing 345 to 755 lb., and stands weighing 700 to 1,017 lb. have resulted in mis-machining, which has been repaired satisfactorily by metallizing. A mis-machined 3,600-lb. cast steel shaft, valued at $1,200 when finished, was metallized back to required dimensions by Canadian Vickers, Ltd. Approximately 6,000 roller spacers of seamless steel tubing were found machined 0.015 in. short. These were built up to required size by Atlas Metal Spray Company, Philadelphia. All such applications are examples of considerable savings in time, labor and material.

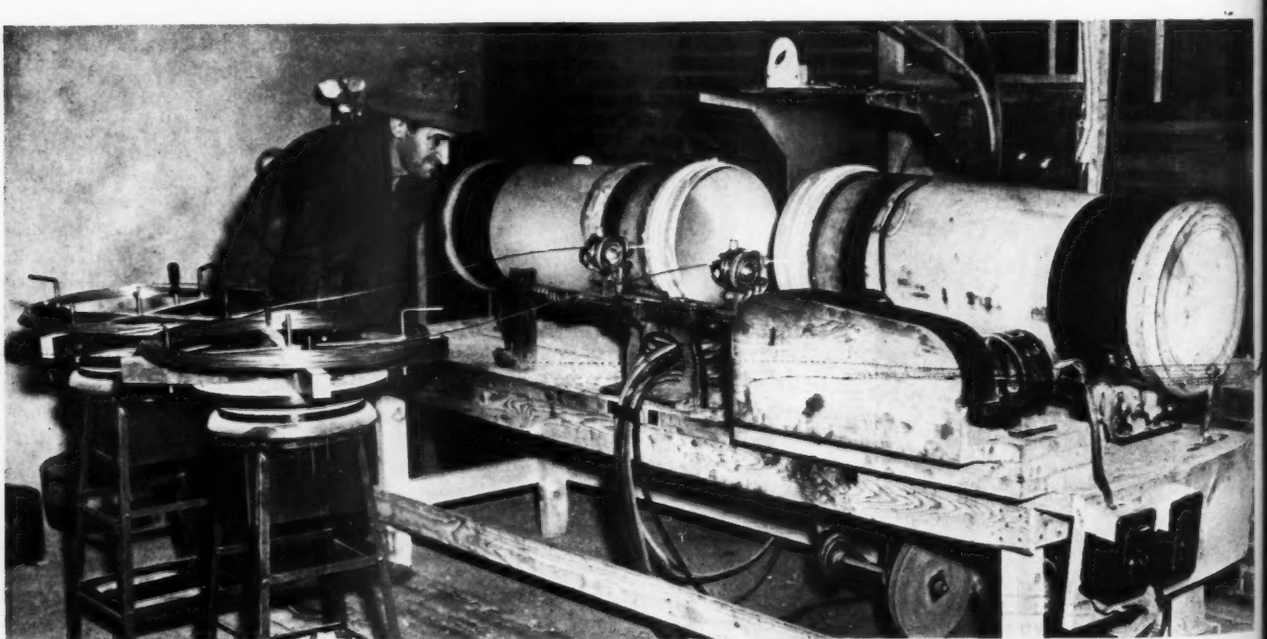
Non-Metallic Parts

Applications of metallizing to other materials, such as cloth, plastics, and glass are most familiar to the electrical industry. Outside this field, an application of metal to glass plate for the manufacture of commercial refrigerators and refrigerated counters for stores is noteworthy. Two layers of glass plate are joined together with an air space between them by first spraying copper along the edges and then soldering the two plates of glass together. This method is employed by Libbey-Owens-Ford. Copper is sprayed on glass by many manufacturers to make electrical contacts, means for soldering, and other purposes. Production coatings of aluminum on cloth for capacitors have been employed by P. R. Mallory & Company.

When a combination of long and short bushings are utilized, as in the horizontal drawout type of oil circuit breaker, the long bushings must be surrounded with a metal cylinder from the grounded head of the breaker to a height sufficient to make the external flashover value of the long bushings equal to that of the short ones. Brass or other non-ferric casting are expensive, particularly since a tight fit is necessary to avoid corona difficulties. Bushings of mold-cured laminated phenolic Bakelite metallized with zinc by Roller-Smith Company to a thickness of several mils have satisfactorily met the requirements.

Most common application of metallizing wood is in foundries where its value in repairing or lengthening the life of patterns has been discovered.

Post-war applications may well show further development in production procedure, which will increase speed and uniformity of coatings, whether applied to metals or to other materials such as cardboard, leather, textiles, carbon, wood, or plastic.



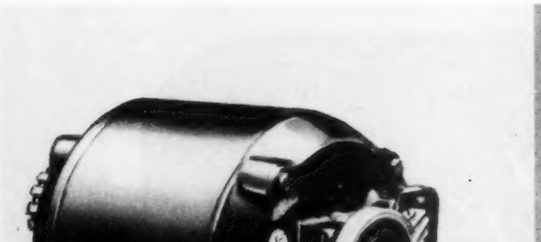
Simultaneous spraying of 0.030-in. coat of bronze at the mouths of two powder tanks is accomplished in this production set-up at Floyd-Wells Company plant. Bronze coating serves to make the openings spark-proof. A primer coating of zinc improves bond.

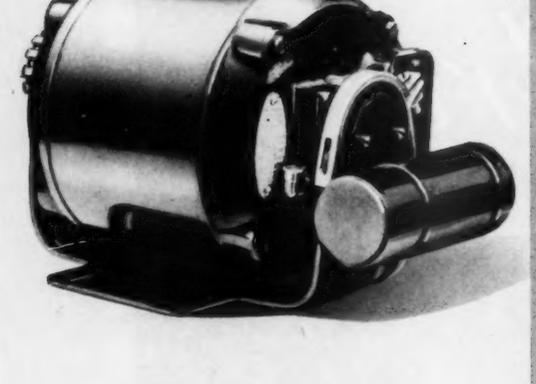
Electric MOTORS

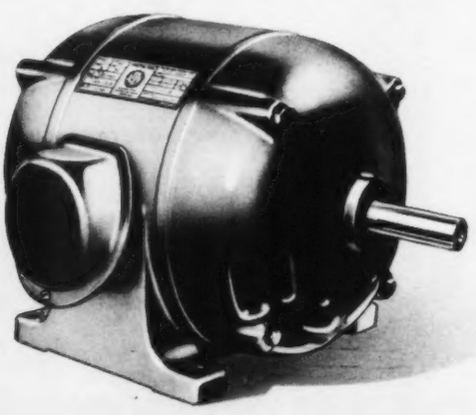
FOR PRESENT AND POST-WAR PRODUCTS

An editorial summary of developments in electric motors for industrial, domestic and aircraft accessory applications, with eference to mechanical and electrical characteristics.

DEVELOPMENTS IN MOTOR DESIGN







• Research projects and design studies that have been carried on in the field of highly specialized war equipment form a promising background for improved post-war motors for industrial, commercial, and domestic applications.

General purpose motors have been redesigned by practically all motor manufacturers. In the new designs, all internal motor parts are fully protected against flying chips, falling particles and dripping liquids by the elimination of all openings in the upper half of frames and end bells. Openings for ventilation are in the under side of end bells.

Fractional hp. motor designs, formerly used in large quantities in home appliances, have been improved to suit special applications such as compressor motors for tanks, high-frequency motor-generators for testing, motors for aircraft cameras, machine tool motors, gun-cooling pump motors, and ventilating fan motors for gun turrets.

Aircraft motors are of special mechanical and electrical construction to obtain light weight, to meet small space requirements, and to withstand excessive vibration, extreme atmospheric temperature and weather conditions.

Direct current battery operated motors have been developed to drive small accessories on flying and mobile war equipment.

Continuous research is in progress to determine which lubricants are best suited for operations over a wide range of temperatures under both intermittent and continuous duty cycles.

Design studies are under way to develop small motors that will have sufficient oil capacity, or other means of adequate lubrication, so that they will not require additional lubricant after leaving the factory.

MATERIAL AND DESIGN IMPROVEMENTS

• Aluminum, magnesium, and sheet steel are used to minimize weight of frames and housings.

Improved steels reduce electrical losses and give increased output per pound of material. Iron for laminations and copper for windings are used more efficiently in new designs.

Copper saving designs that reduce weight of both motor and wiring systems in aircraft have been developed to offset increasing electrical loads.

Smaller high speed rotating parts also are used to reduce weight.

Inorganic compounds and materials for winding insulations have been improved to resist high temperatures.

Stator insulation life is prolonged by uniform cooling and elimination of hot spots.

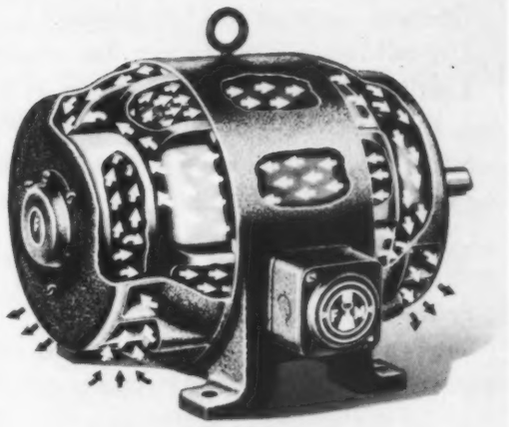
Heat dissipation has been improved through efficient proportioning of heat-conducting parts and directed or controlled flow of cooling air in both single-end and double-end ventilating arrangements.

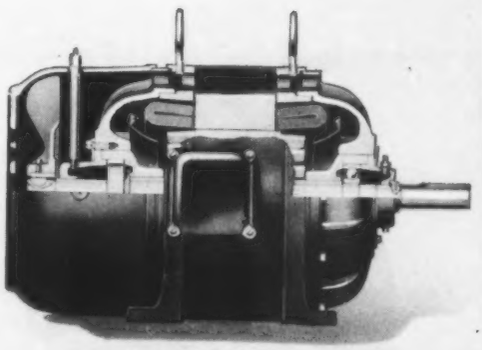
Loss of oil caused by circulation of air directly from the outside and through bearings is prevented by oil baffles, slingers, and labyrinth packing on the motor or inboard side of each bearing. In dusty locations, these devices help prevent abrasive dust reaching shaft and bearing surfaces.

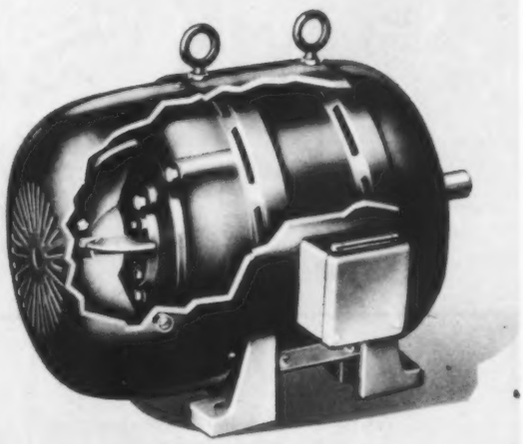
Overgreasing and subsequent overheating of bearings are prevented by grease chambers with pressure relief arrangements. In one design, fresh grease is directed into the bearing by two baffles cast integral with the end shield; wornout grease is forced downwards and out through pressure relief hole.

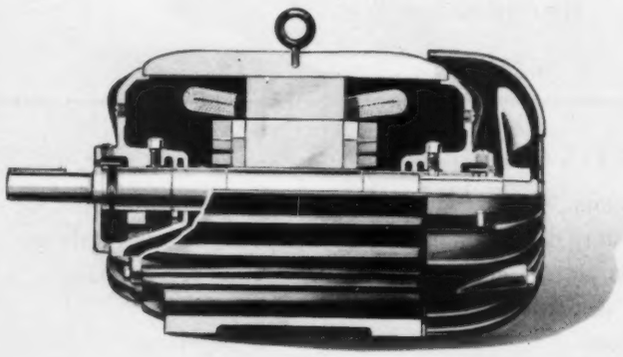
Long running fits at bearings prevent entrance of dust, dirt, water and corrosive materials.

Cartridge-type bearing housings exclude dirt even though rotor assembly is removed from the motor.









DIMINUTIVE MOTORS

FOR SMALL DEVICES, D.C. OR DRY CELL POWER

- One to two watts output.

Operates on either 6, 12 or 24 volts.

Dry cell batteries can be used for power.

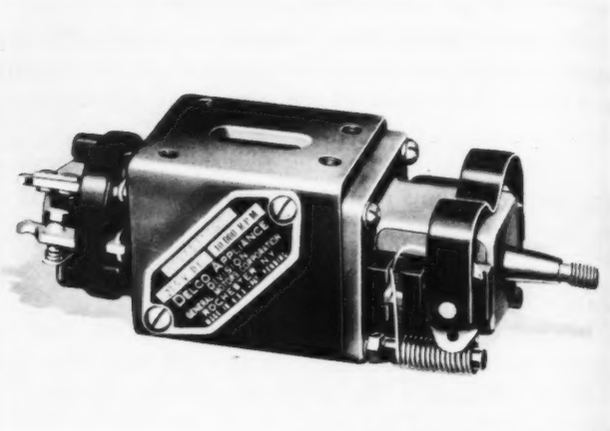
Lubricated to start at temperatures as low as —50 deg. F., and attain full rated speed in two minutes.

Speed ranges from 5,000 to 12,000 r.p.m. depending upon rotor winding.

Governed speed if desired—mechanical speed governor can be mounted on shaft extension.

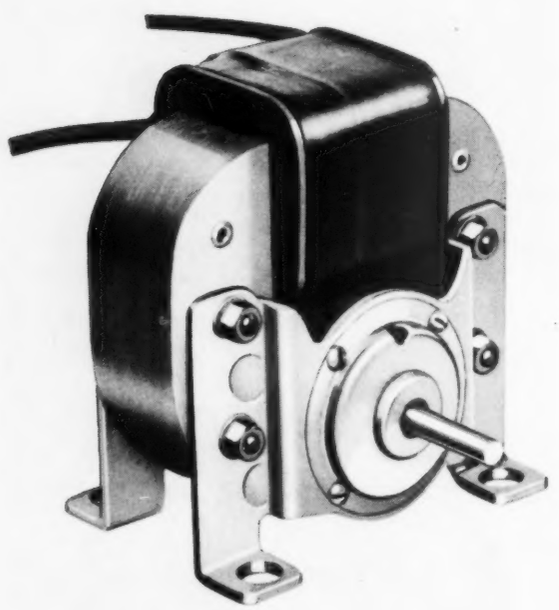
Permanent magnet is used for stator.

Die-cast aluminum alloy housing is cast around magnets, making a compact rigid unit.



Delco Appliance Division, General Motors Corporation

FOR SMALL POWER REQUIREMENTS



Barber-Colman Company

- Four to twenty watts output.

Operate on 105-120 volt, 60 cycle, a.c. supply.

Special motors for voltages from 6 to 260, at 25 to 80 cycles.

Integral bridge-type construction with heavy shading characteristics.

Stainless steel shaft, ground and polished.

Self-aligning graphited bronze bearings.

Wick type oilers are inclosed to prevent drip and evaporation.

Bronze bearings without oil cups are supplied when motors operate immersed in light mineral oil.

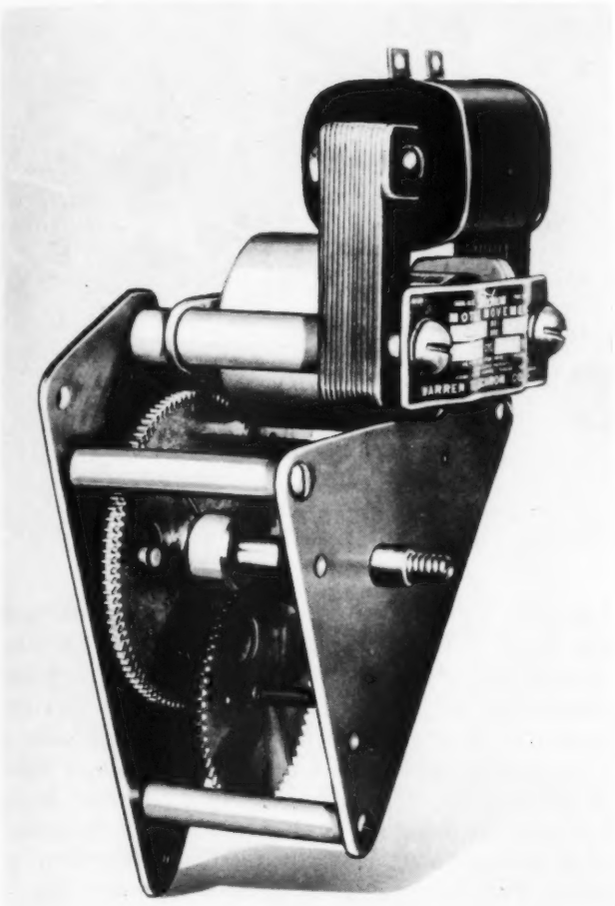
Dust seals can be placed between bearing plates and motor laminations to prevent dust and lint from entering air gap between rotor and stator.

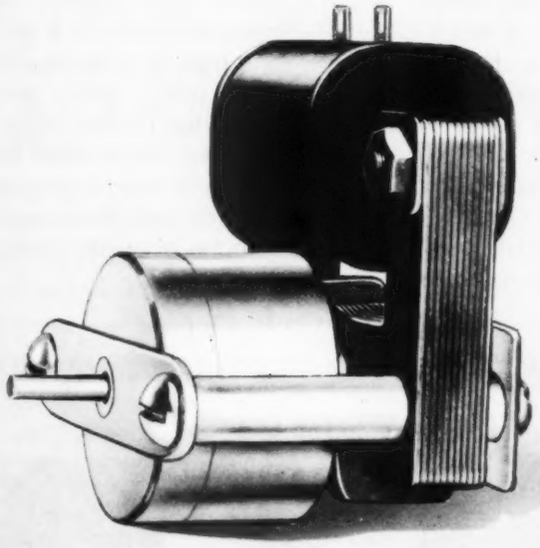
Rust-resistant motors have all laminations coated with iron phosphate before stacking. Rotors are cadmium plated after grinding.

APPLICATIONS

Advertising machines	Incubators	Program switches
Revolving barber poles	Laboratory devices	Temperature regulators
Damper controllers	Motion picture projectors	Time delay contactors
Hair dryers	Small ventilators	Toys
Humidifiers	Ozonizers	Refrigerators

SMALL HYSTERESIS MOTORS FOR CLOCKS AND TIMING DEVICES





Warren Telechron Company

• Speed of motor keeps in absolute step with the frequency of the energizing a.c. power.

Residual magnetism is used for self-starting and for operation.

Operation not affected by voltage drops of 20 percent under rated load conditions.

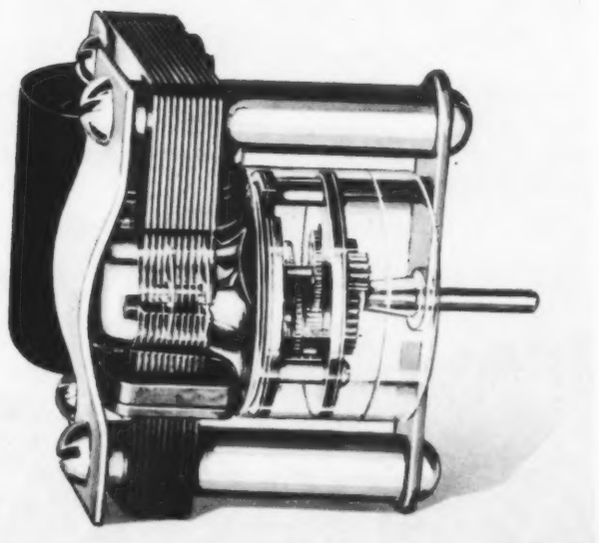
Temperature variations between 0 and 100 deg. F. do not affect operation.

Time and step of a number of motors, connected to same power system, will be kept without individual variation after having been properly set.

Built to suit any one commercial voltage and frequency, and for any one speed at the terminal shaft.

APPLICATIONS

Recording instruments	Process and operation timers
Alarm and signal systems	Program instruments
Coin-operated timers	Revolution counters
Cycle controllers	Time relays and switches
Electric clocks	Timing elements



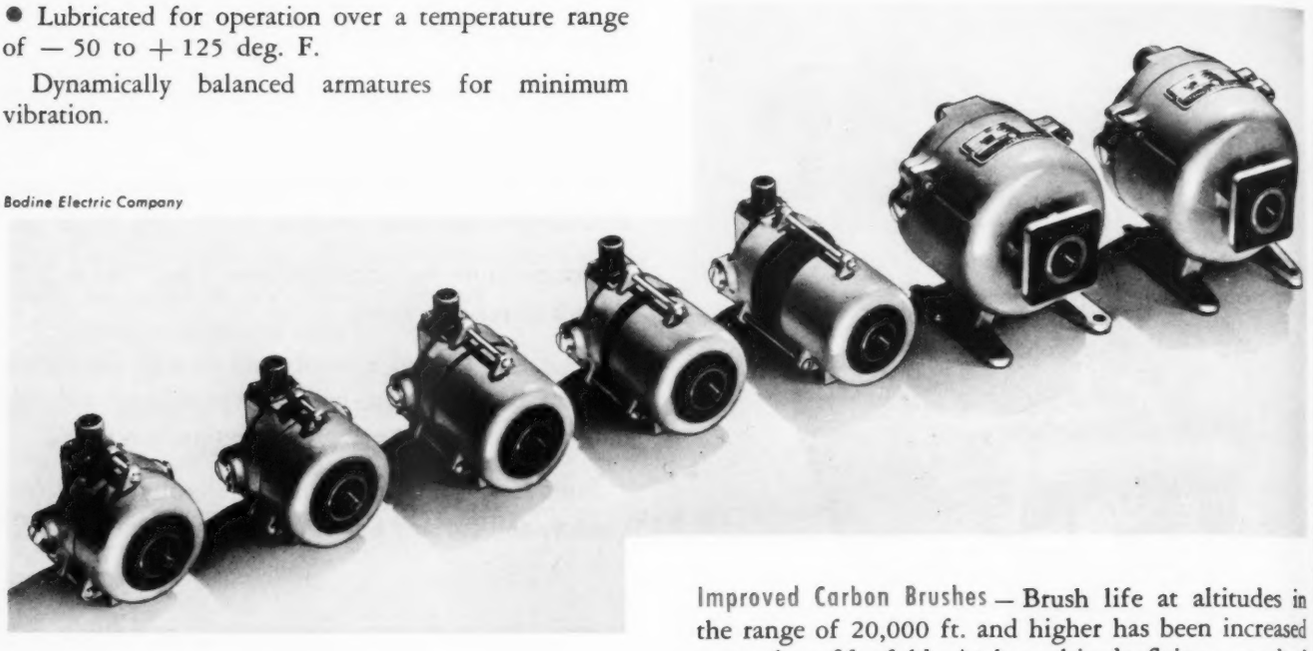
DEVELOPMENTS IN AIRCRAFT MOTORS

CONSTRUCTION FEATURES AND TYPES

● Lubricated for operation over a temperature range of — 50 to + 125 deg. F.

Dynamically balanced armatures for minimum vibration.

Bodine Electric Company



Fibre inserts in nuts to prevent loosening. Screws are safety-tied with wire.

Receptacle-type terminals to receive plug connectors eliminate use of tools in making connections while installing, or breaking connections when dismantling. Tongue and groove design assures correct polarization when changing motors by preventing improper mating of terminals. Plugs and receptacles are locked together by means of quick-acting threaded ring or collar.

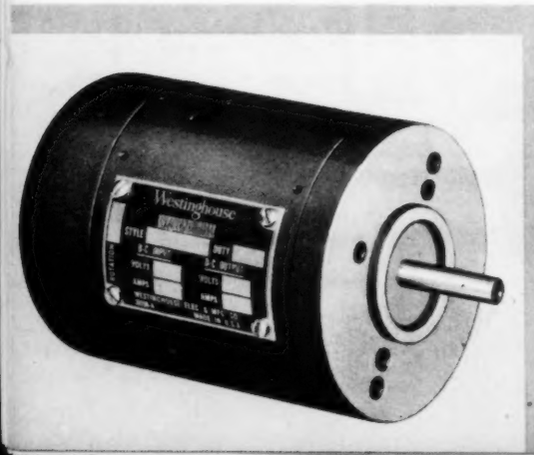
Series, split-series, and shunt wound for either 12 or 24 volts d.c., in ratings for intermittent and continuous duty. Intermittent duty motors after each operation must be allowed to cool to ambient temperature before starting again.

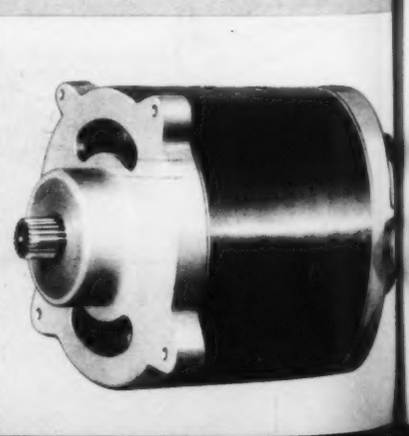
APPLICATIONS ON AIRCRAFT

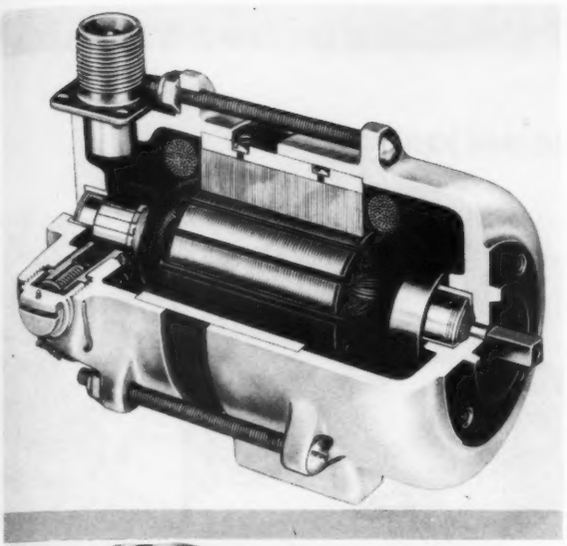
Fuel pumps . . . De-icers . . . Anti-icers . . . Propeller featherers . . . Retractable landing lights . . . Retractable landing gears . . . Recording devices . . . Controlling devices.

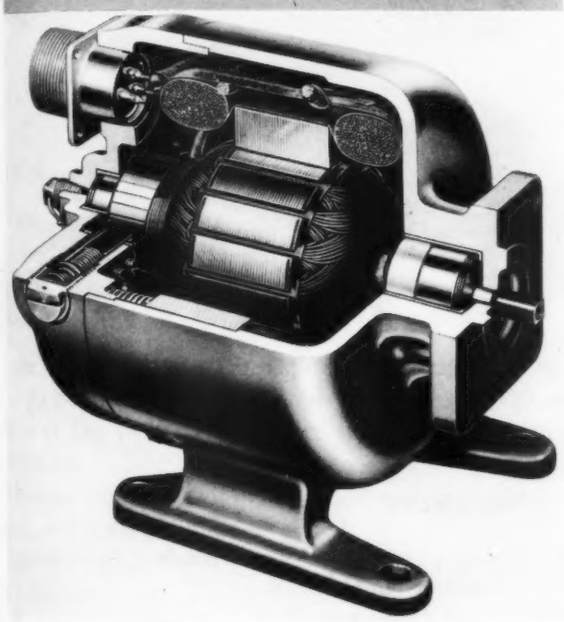
Improved Carbon Brushes — Brush life at altitudes in the range of 20,000 ft. and higher has been increased more than fifty-fold. At low altitude flying, standard carbon brushes operate satisfactorily, but at high altitudes thin air and lack of moisture cause the brushes to wear rapidly, sometimes failing during a single flight. With specially treated carbon brushes, wear during high altitude flying has been reduced to one-thousandth of an inch per hour. It is expected that further developments, still on test, will result in even longer life.

Beryllium Copper Brush Springs — Wear of brushes during the running-in period is reduced through use of specially heat-treated and cold-worked beryllium copper springs which have high fatigue resistance. Such springs retain their stiffness over long periods, even over wide temperature ranges. Therefore initial spring tension need not be greatly in excess of that desired after conditions have arrived at equilibrium. Hence initial brush pressure on commutator can be set to only slightly more than the final running pressure desired. Brush wear is reduced. Beryllium copper also has desirable corrosion-resistant properties.









Bodine Electric Company

Explosion Proofing – Long flame-quenching paths at each joint prevent gas explosions inside of totally inclosed aircraft motor from reaching outside. In this design, long path is obtained by putting an aluminum sleeve on the shaft next to the bearing at the shaft extension. Close bearing fit over wide temperature range is obtained by employing a steel sleeve in bearing chamber. Coefficient of expansion of steel sleeve approaches that of ball-bearing outer case.

Oil Lubrication – In one series, ball bearings are lubricated by oil-saturated woven felt washers adjacent to the inner case. In another series designed for operation at higher temperatures, bearings are lubricated by oil bleeding into them from grease in an adjoining cavity, this prevents sticking caused by soap base remaining in the bearings after high temperature operation.

Lightweight Metals – Magnesium alloy frame castings.

Aluminum alloy bolts, screws and other small parts in the assembly.

Corrosion-resistant Air Corps No. 7 protective treatment and zinc chromate coat is applied to castings. Outer finish is applied by accessory manufacturer after assembly to the driven apparatus.

Heat Resistance – Glass and other types of insulated wire to suit operating temperatures are used for field coils. Coils are taped with glass and linen tape, dehydrated and impregnated with high-temperature varnish and baked.

Steel shell housings for light weight and rigidity.

Aluminum or magnesium end shields to save weight.

Inserts in end shield castings house double-shielded ball bearings.

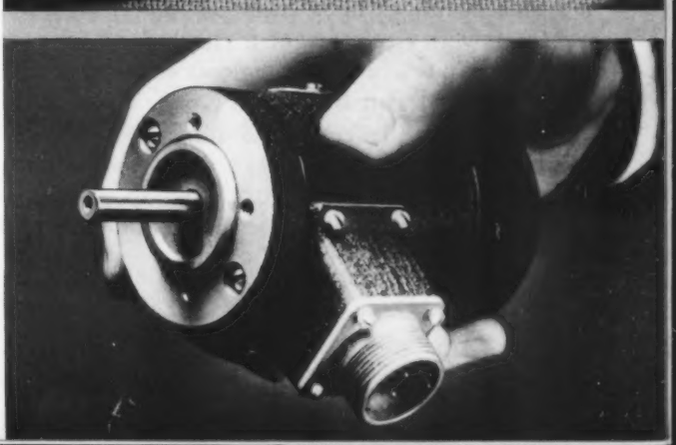
Resistance to aging and heat shock is obtained in field windings through use of synthetic enamel-coated wire. Class B insulation is used throughout rotor. Rotors, after winding, are treated with a bonding and heat-resistant varnish. Stator is treated with varnish after field coils are assembled.

Finish. Aluminum castings are anodized. Exposed steel parts are cadmium plated. Zinc chromate primer for aluminum castings and black wrinkle finish can be added.

Multipolar designs with laminated pole pieces bolted into stator yoke decreases both size and weight.

Splines, threads, pinions, worms, keyways, flats or squared extensions, when required are cut on heat-treated alloy steel shafts.

General Electric Company



AIRCRAFT MOTORS

LOW WEIGHT-POWER RATIO

● Four frame sizes are used in a series of 24 volt, d.c., motors with outputs ranging from 2 watts to 8 horsepower.

Length of motor is varied in each frame size until practical considerations make it desirable to go to the next larger or smaller diameter frame.

Low weight-power ratio is obtained by eliminating all materials not required for useful work. Units are almost solid metal.

Small space required is result of distributing iron for the field and armature to obtain uniform magnetic flux density in all parts of motor.

High operating temperatures made possible by use of glass enamel coated wire with an insulation of fiber glass and mica.

Movement of windings in service is eliminated by vacuum impregnating the wound units and baking them to form a solid insulated body free from voids.

Lear Avia, Inc.

Intermittent duty motor rated at 12 watt output, speed 13,000 r.p.m., with aluminum castings and electromagnetic clutch, weighs 0.81 lb. Over-all dimensions are $1\frac{9}{16}$ x $1\frac{9}{16}$ x $4\frac{41}{64}$ in. A 3 h.p. motor of similar type and construction, except speed is 9,000 r.p.m., weighs $17\frac{3}{4}$ lb., over-all dimensions are $4\frac{15}{16}$ x $5\frac{1}{2}$ x 11 inches.

ELECTROMAGNETIC CLUTCH DRIVE

● Stopping driven parts in any desired position is accomplished by de-energizing the disk clutch and applying brake when d.c. motor current supply is cut off. Motor armature, with its high inertia, coasts to a stop.

Stationary electromagnet coil is connected in series with the motor. Driving disk of magnetic material is integral with armature shaft. Driven disk, also of magnetic material, is integral with motor output shaft. When current is supplied to motor, the electromagnet coil is energized and draws the driven disk against the rotating driving disk. The disks held together magnetically rotate as a unit, thus driving the motor output shaft.

Magnetic attraction ceases between the driving and driven disks when current supply is cut off, thus de-energizing the coil. Driven parts are stopped almost instantly as spring uncouples the driven disk and presses it against stationary brake disk.

Motors with electromagnetic clutch drive are suitable for applications where requirements are: —

Accurate indexing of a moving part.

Return to a predetermined initial position of indexing.

Given load to be released or picked up quickly.

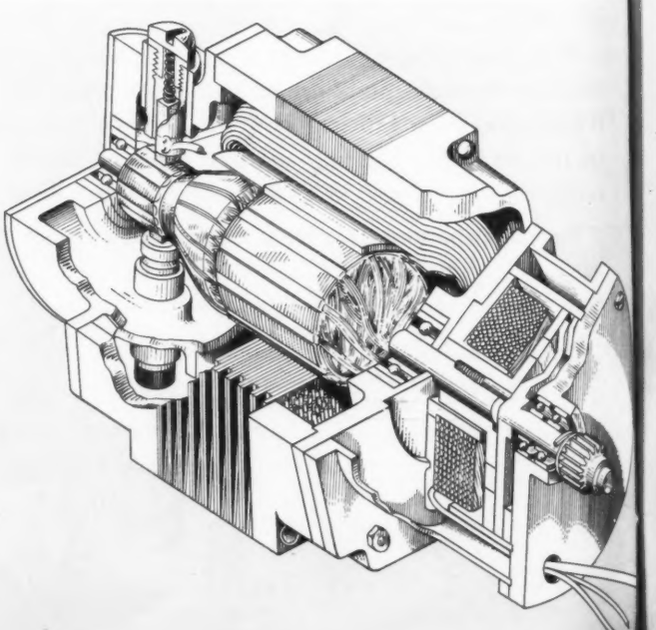
Abrupt stopping, starting or shifting of a device with mechanical or with photocell control.

Releasing or picking up loads after driving unit has reached a predetermined speed.

Timing fixed cycles with high accuracy.

Exact positioning of parts by remote motorized control.

Abrupt starting or stopping of driven members in response to control signals.



HIGH-FREQUENCY A.C. MOTORS

• Electrical loads on military airplanes have grown greatly in the last three years because of the increasing use of electric power to drive auxiliaries, the use of motor-driven instead of engine-driven hydraulic pumps, and the development of new flight and combat devices.

Excessive copper weight has been avoided by increasing the line voltage and using high-frequency motors.

Weight of copper and iron needed per motor horsepower is smaller with high-frequency design. A 400-cycle motor requires about 1/7 of the iron used in a corresponding 60-cycle motor, which in turn reduces the amount of copper needed.

Commutator and brush maintenance problems are eliminated through use of alternating current.

Motors have been developed for 400- and 800-cycle, single-phase, 60 or 120-volt circuits, and also for 400-cycle, 3-phase circuits for operating pumps, blowers, actuators and other aircraft equipment.

★ ★ ★

Single-Phase High-Frequency Motor and Blower

Operates on power supply of radio transmitter, 800- or 400-cycle, consumes approximately 20 watts.

Can start at temperatures as low as —30 deg. F., and will run in high ambient temperatures.

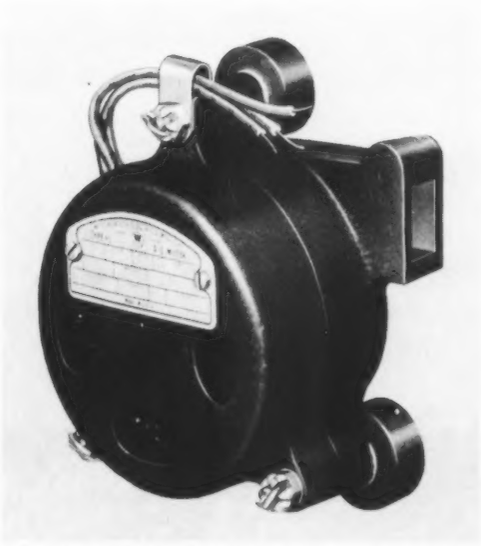
Stator is locked with an aluminum band.

Vibration is minimized by dynamically balancing rotor and blower fan as a unit. Rubber shock mounts also are sometimes provided.

Either 60 or 120 volts can be used depending upon capacitor required with motor.

Speed of motor is 6,700 r.p.m. Weight, less capacitor, is approximately 24 ounces.

Self-contained motor and blower unit is used for air circulation and ventilation in radio equipment.



Westinghouse Electric & Manufacturing Company

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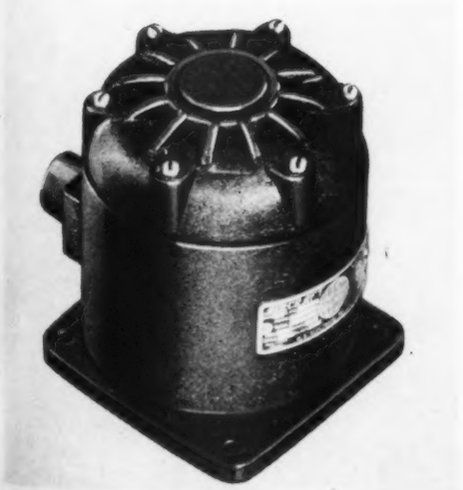


U.S. Electrical Motors, Inc.

Three-Phase High-Frequency Motors

Intermittent and continuous duty motors designed to operate on 3-phase, a.c., 400-cycle circuits. Sizes range from 1/8 to 15 h.p. Synchronous speeds are 6,000, 8,000, and 12,000 r.p.m.; lower speeds are obtained with integral-type gear reducers.

Bearings with self-contained seals are pre-packed with low temperature grease to meet Air Corps specifications.

Magnesium alloy housings combined with the weight economy inherent in 3-phase high-frequency power are factors that make possible a high power-weight ratio.

Windings are stationary. Standard AN type connectors can be supplied.

Motors are finished in black wrinkle enamel.

HIGH-FREQUENCY MOTORS

SHELL-TYPE MOTORS

● Close center dimensions in multiple shaft or spindle machines, can be obtained by using built-in polyphase squirrel cage induction motors, which consist of a shaftless rotor and a shell that contains stator punchings and windings.

Compactness is achieved by keeping over-all diameter of motor small and using longer parts than those built into standard motors.

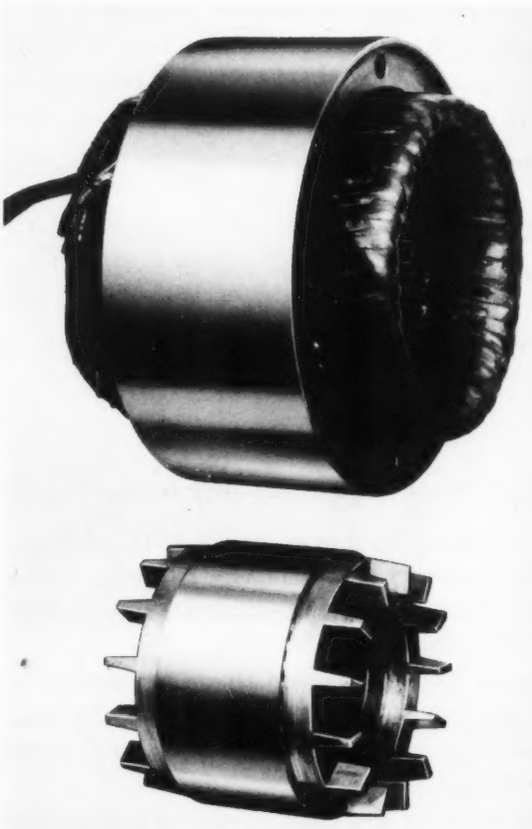
Small diameter of rotor makes it inherently suitable for operation at speeds much higher than 3,600 r.p.m.

Speeds of 32,400 r.p.m. are attained with 2-pole motors operating on frequencies of 540 cycles. Research and laboratory studies now in progress point toward much higher speeds, in one case 200,000 r.p.m. Multispeeds are obtained by using a multifrequency power supply.

Designer of the driven machine must make arrangements for bearings, lubrication, ventilation, and balancing at critical speeds.

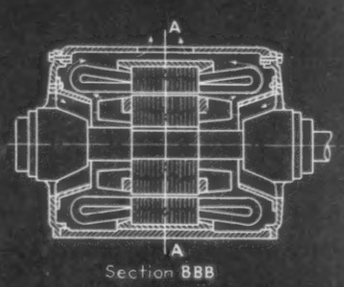
Applications for shell-type, high-speed motors are:

Boring machines, multiple-spindle drilling machines, grinders, saws, wood-working machinery, rayon and thread spinning machines.

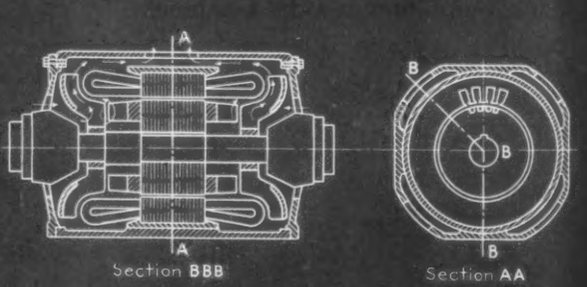


General Electric Company

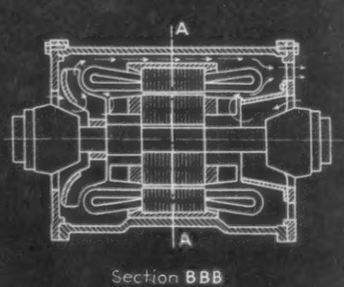
METHODS OF VENTILATING SHELL-TYPE MOTORS



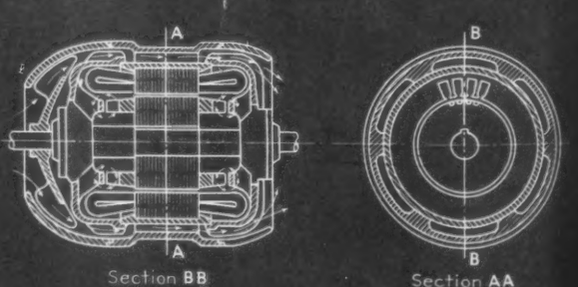
Open, double-end ventilated.



Open, double-end ventilated, with two shaft-mounted auxiliary fans.



Open, single-end ventilated, with one shaft-mounted auxiliary fan.



Totally inclosed, fan cooled, single-end ventilated, with one shaft-mounted external fan.

TORQUE MOTORS

FOR ACTUATING DEVICES THAT STALL

• Operating requirements of the actuated machine or device determine the designed-in working characteristics of the motor.

Ratings, in lb. in. or lb. ft., are built to suit the expected stalled and running torque requirements involved during the cycle of operation.

Frequency of operation, length of time that motor is connected to power supply, permissible temperature rise, and dimension limitations, all influence the design of the motor.

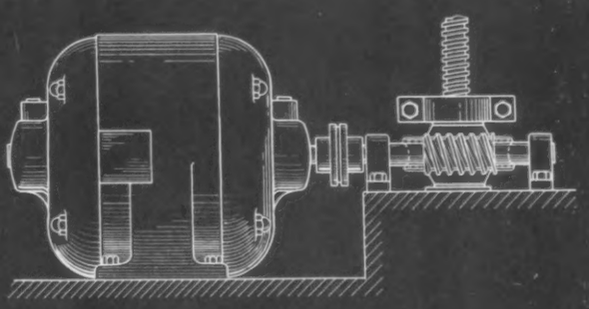
Built for both a.c. and d.c. operation.

Can be readily attached to or built into machines, and operated through remote control.

Advantages obtained with torque motors:

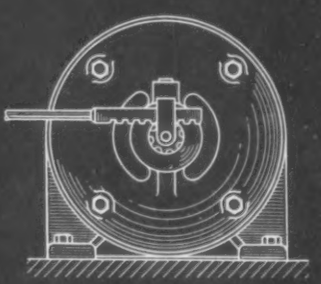
Install a specified amount of driving or holding force in a small space.
Can be mounted in any position.
Can be used instead of solenoids or magnets.
Provide maximum power at start.
Can be quickly reversed.
Simplify complicated mechanical methods.
Put power where it is wanted.

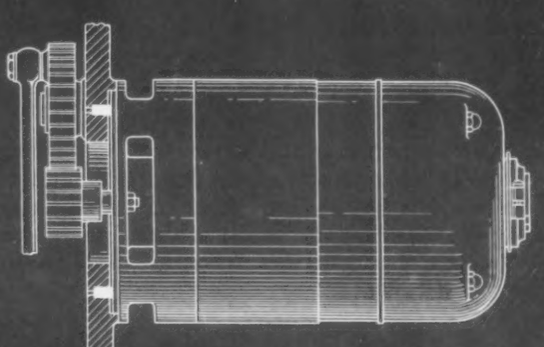
B. A. Wesche Electric Company



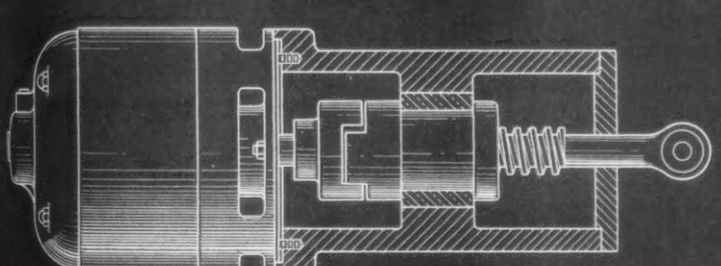
Foot-mounted motor joined by a flexible coupling to a worm and wormwheel which operates a screw.

Foot-mounted motor with rack and pinion to convert rotary motion into traverse motion.

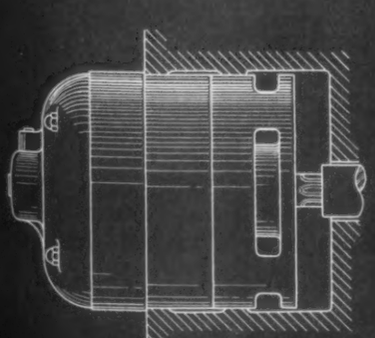




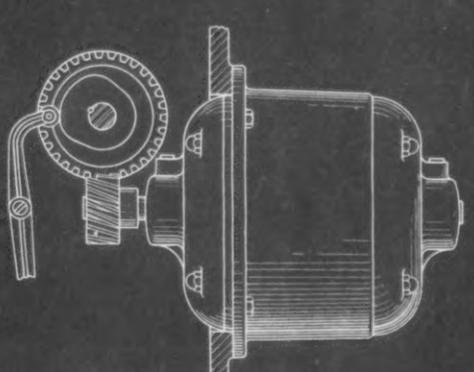
Mounted on flanged bracket. Torque motor is equipped with a brake to obtain quick stopping at any point in cycle. Motor is coupled to a crank through a gear reduction.



Flanged bracket mounting, with flexible coupling and screw to transform rotary motion to traverse movement. Force delivered depends upon the pitch of screw.



Motor frame is machined to fit machine member. Motor shaft is splined to fit coupling or driven member.



Flanged frame mounting. Right-hand spiral gear operates cam and arm mechanism.

ADJUSTABLE-SPEED A.C. MOTORS

FOR SPEED REGULATION OVER WIDE RANGE

● Variable speed to suit requirements of processes that are timed on the basis of production conditions or other variables.

Efficient utilization of machine capacity inherent in speed regulation over a wide range.

Slow speeds when beginning operations for threading and feeding materials.

Sensitive control of torque at starting.

Speed regulation by means of the ordinary slip-ring induction motor is not always satisfactory. When d.c. is available, speed regulation is not a problem since the d.c. shunt motor has excellent regulation characteristics.

Advantages obtained with adjustable-speed motors:

No intermediate variable speed unit between motor and machine.

Operating speeds are obtained over a wide range.

Speed adjuster can be placed for convenience of the operator.

Motor can be stopped and started without interfering with the speed setting.

Slow speeds can be had while threading material by hand or inching when setting up work.

Ample torque with controlled acceleration for all starting conditions.

FULL TORQUE OVER SPEED RANGE

● Operates at an infinite number of speeds between a minimum of a few r.p.m. and a maximum of 1,720 r.p.m.

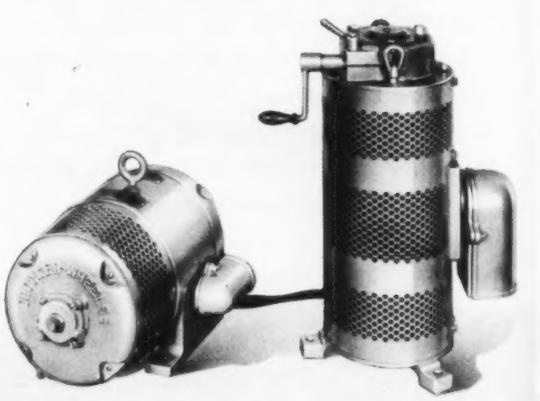
Full load speed range in continuous operation is 580 to 1,720 r.p.m. for standard motors.

Ratings range from 1 to 7½ hp., for operation on 220-, 440- or 550-volt, 3- or 2-phase, 60-cycle circuits.

Speed depends upon the voltage applied to the rotor winding. Adjustable voltage to rotor winding is obtained from an induction-type voltage regulator.

Operating characteristics are similar to those of a d.c. shunt motor.

Construction Features. Stator core and windings are similar to those of an induction motor. Stator windings are connected directly to the line and require no current adjustment. Rotor winding is similar to a d.c. motor armature winding and is connected to a commutator. Brushes are set in a fixed position.

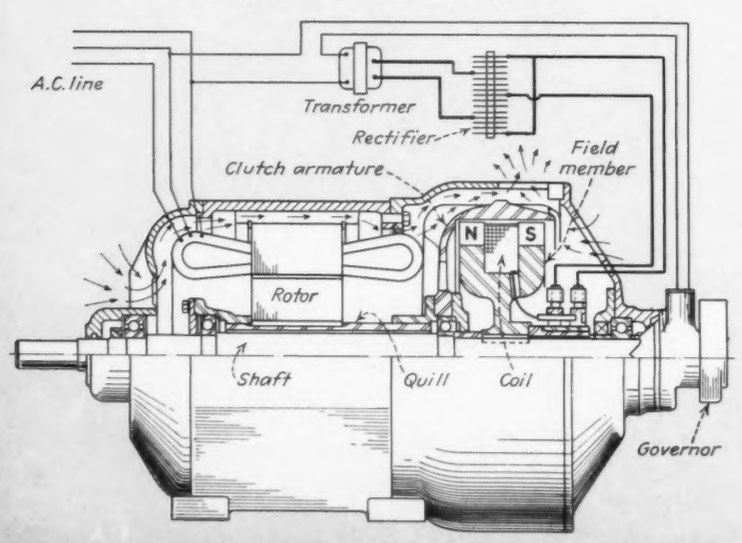


Crocker-Wheeler Electric Manufacturing Company

EDDY CURRENT SLIP CLUTCH MOTOR

Louis Allis Company

General construction of eddy current slip clutch motor with typical excitation arrangement.



● Speed variation obtained by varying the slip between clutch armature and field member by changing excitation through voltage regulation. With constant excitation, torque increases with slip.

Excitation is produced by d.c. from transformer and rectifier.

Rotor of a.c. motor is mounted on quill which is free to turn on motor shaft.

Magnetic steel ring-shaped clutch armature is attached to quill.

Field member, also of magnetic steel, inside of clutch armature carries coil and field poles. Coil receives d.c. excitation through two collector rings in circuit with rectifier.

Output shaft extends through motor and is driven by attached field member rotated by magnetic force which acts to pull the two clutch members into step.

GOVERNOR-CONTROLLED MOTORS

FOR MAINTAINING SELECTED SPEEDS

• Centrifugal switch governs speed of universal series-wound motors or shunt-wound d.c. motors rated from 1/50 to 1/10 hp.

Governor is also used on series universal motors to secure equal a.c. and d.c. speeds, and on d.c. shunt motors for applications normally driven by a.c. synchronous motors.

Resistance and capacitance values are determined experimentally. Specific applications determine the design of governor-controlled motors.

Racing of the motor is eliminated.

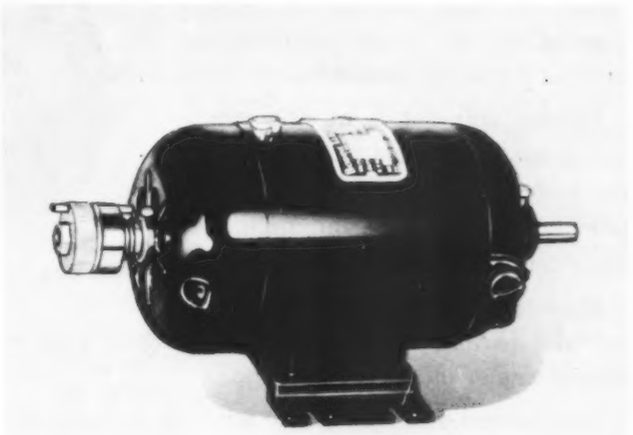
Close speed limits are maintained at selected motor speed, regardless of ordinary changes in voltage, load or frequency.

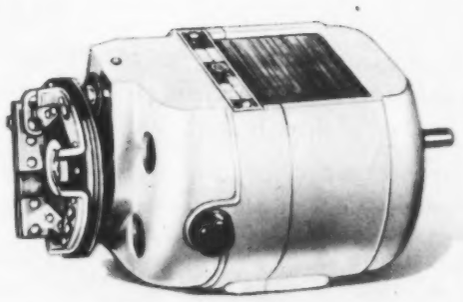
Maximum speed range covered by one governor is from 500 to 6,500 r.p.m.

Speed adjustments can be made while motor is running when one type of governor is used. Another type is available for adjusting speeds only at standstill.

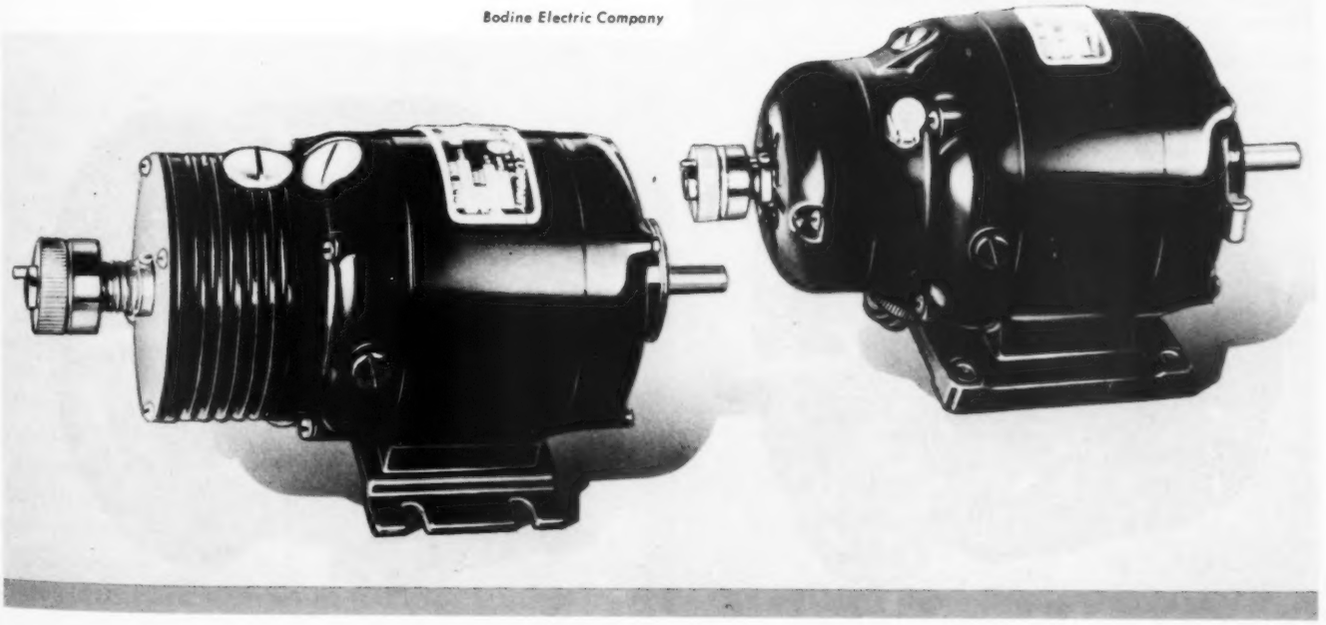
Constant speed on a.c. and d.c. makes these motors suitable for portable motion picture projectors.

High torque on low speeds supplied by governor motors is an important requirement on devices such as domestic food mixers.





Bodine Electric Company

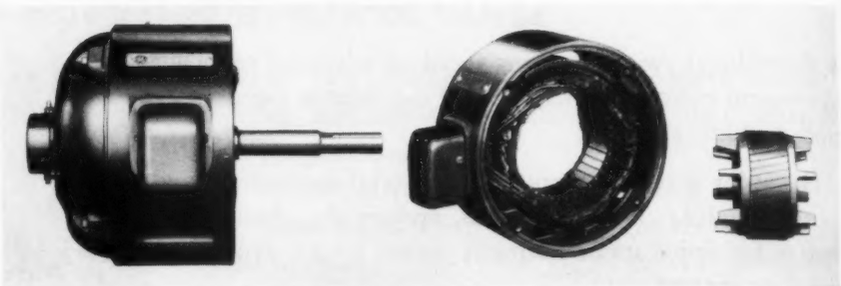


MOTORS TO BUILD INTO MACHINES

PARTIAL MOTORS

● Simple and compact drive arrangements are often possible by using parts of motors to make an integral drive and machine assembly.

Driving unit, consisting of a motor minus end shield and bearing, can be bolted directly to the end or side of driven machine, and machine shaft coupled to motor shaft.



General Electric Company

Short over-all length of driving unit and machine are possible by using motor parts as components of the driven machine.

Compactness in design can be achieved by using motors minus end shields, bearings and shafts, with rotor mounted directly on shaft or spindle of driven machine.

Means for proper ventilation, mounting, alignment and support of bearings when using partial motors, must be provided in the design of the machine.

Applications: Machine tool head stocks, small hoists, gear reducers, grinders, compressors.

FLANGE-TYPE MOTORS

● No base plate needed for support of driving unit when footless round frame motors with flange-type end shields are bolted directly to the driven machine.

No support needed for many types of machines that can be bolted to or overhung on flange-type end shield motors which have feet.

Accurate alignment of motor and driven machine is assured by rabbett in mounting surface of end shield.

Tight-fitting coverplate for machine is provided by solid face of end shield.

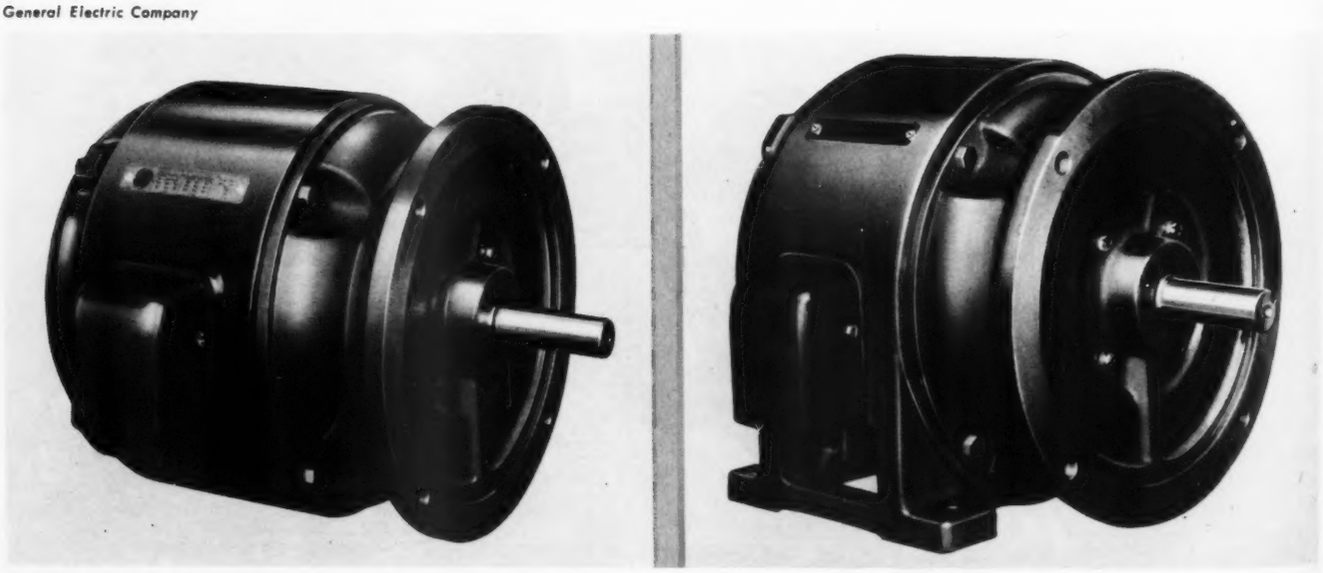
Shaft extension made to suit specifications.

Compact direct drives are possible, without the necessity of the designer providing arrangements for ventilation, lubrication, bearing supports and alignment of connected parts.

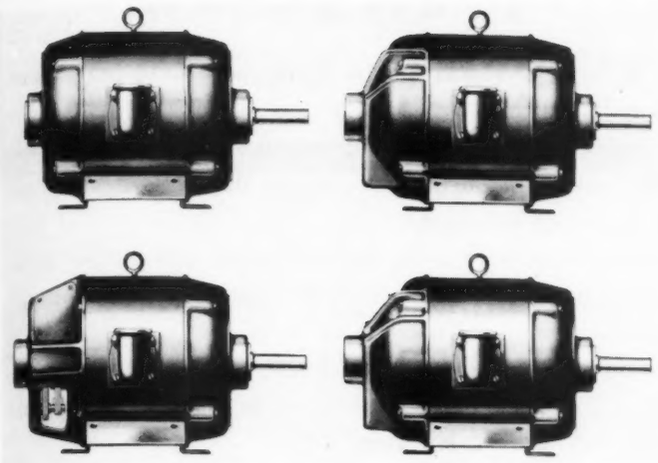
No cooling air comes from the driven machine. Ventilating air inlet to motor is on the motor side of end shield face.

Different installation requirements can be met with little or no change in the design of the machine, since motors of different power and service ratings or types of inclosure can be furnished with the same end shield mounting dimensions.

General Electric Company



INTEGRAL HORSEPOWER MOTORS



Robbins & Myers, Inc.

INTERCHANGEABLE SERIES

● Identical dimensions for shell, head fit, bolt circle holes, shaft size and conduit box mountings made in any one frame size for all motor types.

Mounting arrangements for one type of motor need not be changed or redesigned when requirements make it desirable to install a motor of some other type.

External appearance of motors differs from one type to another only in the motor end head opposite the shaft extension.

Series consists of polyphase induction motors, capacitor-start induction motors, standard d.c. motors and generators, single-phase repulsion-start induction run motors, and other types.

TOTALLY INCLOSED INDUCTION MOTOR

Metal Dust Explosion Proof—External parts do not get hot enough under permissible loads to cause ignition of surrounding dust, despite the insulating effect of a covering of dust.

Smooth contours facilitate cleaning.

No dust which might cause an internal explosion can enter the motor.

Dust excluded from the bearing housing by means of rotating labyrinth seal at the shaft opening and a complete cast iron bearing inclosure.

Pressure relief lubrication system provides for the greasing of bearings without disassembly of dust-tight inclosures.

Developed to meet need brought about primarily by the extensive use of magnesium and aluminum in war production in metal working and ordnance plants, where combustible metals are being handled in powdered form, or where machining, grinding, or polishing operations are performed.

General Electric Company

DOUBLE-REDUCTION GEARMOTOR

● Self-contained drive unit consisting of motor and speed-reducing unit.

High efficiency inherent in high-speed motor retained by utilizing gear reduction to obtain low output speeds.

Simplified design assures minimum maintenance and replacement.

Split-case construction makes all gear units readily accessible.

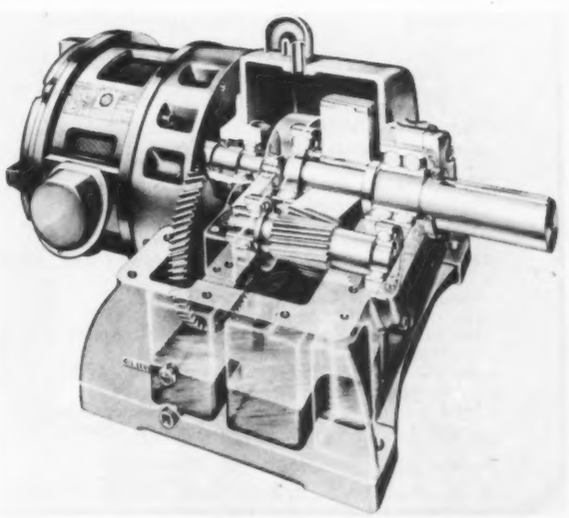
Built to suit any of a variety of industrial applications. Designs are in accordance with American Gear Manufacturers Association recommended practice.

Positive splash system lubricates gears and bearings including motor bearing in gear unit.

Grease-lubricated bearing in front motor bracket.

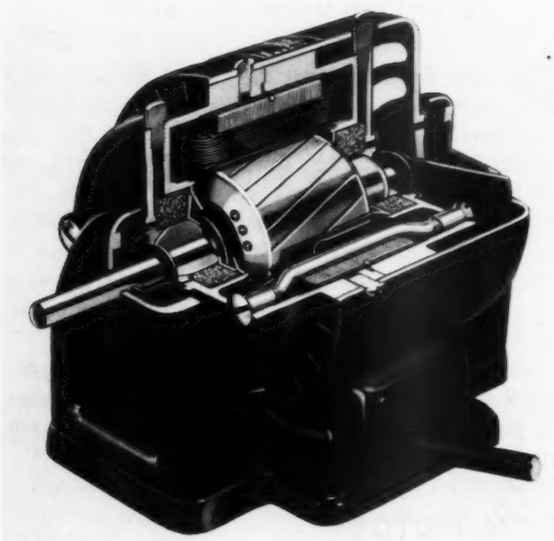
Breather equalizes pressure to assure cool operation. Filter is provided for inclosed motors or dusty atmospheres.

Quiet smooth operation is obtained with helical gears and pinions having maximum tooth overlap.



Westinghouse Electric & Manufacturing Company

BEARINGS



A. G. Redmond Company

BALL AND SOCKET TYPE

● Self-aligning porous-type bearings of long length promote long life.

Bearings are fed from oil saturated wool felt reservoir. Felt retains oil during shipping so that motors are ready to run when received.

Oil flinger on outside and oil flinger and catcher at inside of motor bearings throw oil which seeps out through bearing clearance back into oil reservoir.

Cooling shell on totally-inclosed, shaded, pole-type motor, 1/25 to 1/125 hp., guides air from fan through radiating fins on die-cast frame.

ELECTRICAL MOTOR MANUFACTURERS

Adel Precision Products Corp., 10777 Vanowen St., Burbank, Cal.
Advance Electric Company, St. Louis, Mo.
Alliance Mfg. Company, Lake Park Blvd., Alliance, Ohio
Allis Chalmers Mfg. Company, 1126 South 70th St., Milwaukee, Wis.
Armor Electric Mfg. Company, Erie, Penn.
Baldor Electric Company, 4353 Duncan Ave., St. Louis, Mo.
Barber-Colman Company, River & Loomis St., Rockford, Ill.
Black & Decker Company, 1708 Union Commerce Bldg., Cleveland, Ohio
Bodine Electric Company, 2254 West Ohio St., Chicago, Ill.
Burke Electric Company, 12th & Cranberry Sts., Erie, Penn.
Century Electric Company, 1806 Pine St., St. Louis, Mo.
Cleveland Electric Motors, Cleveland, Ohio
Crocker-Wheeler Company, Ampere, N. J.
Delco Appliance Div., General Motors Sales Corp., 391 Lyell Ave., Rochester, N. Y.
Diehl Manufacturing Company, Elizabeth, N. J.
Dumore Company, 14th & Racine Sts., Racine, Wis.
Eicor Inc., 1060 West Adams St., Chicago, Ill.
Electric Specialty Company, Stamford, Conn.
Emerson Electric Mfg. Company, 1824 Washington Ave., St. Louis, Mo.
Fairbanks Morse & Company, 600 South Michigan Ave., Chicago, Ill.
Fidelity Electric Company, 332 North Arch St., Lancaster, Penn.
General Electric Company, 1 River Rd., Schenectady, N. Y.
General Industries Company, Taylor & Olive Sts., Elyria, Ohio
Gilbert Company; A. C., 493 Blatchley Ave., New Haven, Conn.
Hamilton Beach Company, Racine, Wis.
Hansen Manufacturing Company, Princeton, Ind.
Harnischfeger Corp., 4400 West National Ave., Milwaukee, Wis.
Heinze Electric Company, Lowell, Mass.
Hertner Electric Company, Cleveland, Ohio
Holtzer-Cabot Electric Company, 125 Amory St., Boston, Mass.
Howell Electric Motors Company, 409 N. Roosevelt Ave., Howell, Mich.
Ideal Electric & Mfg. Company, Mansfield, Ohio
Imperial Electric Company, 84 Ira Ave., Akron, Ohio
Janette Mfg. Company, 556 West Monroe St., Chicago, Ill.
Kimble Electric Company, 2011 West Hastings St., Chicago, Ill.
Kingston-Conley Electric Company, Brook Ave. & Pearl St., Plainfield, N. J.
Lear Avia., Inc., Piqua, Ohio
Leland Electric Company, Webster & Leo Sts., Dayton, Ohio
Louis Allis Company, 427 East Stewart St., Milwaukee 7, Wis.
Master Electric Company, 100 Davis Ave., Dayton, Ohio
Minneapolis-Honeywell Regulator Company, 2747 4th Ave., So., Minneapolis, Minn.
Ohio Electric Mfg. Company, 5900 Maurice Ave., Cleveland, Ohio
Oster Mfg. Co.; John, Racine, Wis.
Peerless Electric Company, 1401 W. Market St., Warren, Ohio
Redmond Company; A. G., Owosso, Mich.
Reliance Electric & Engineering Company, 1088 Ivanhoe Rd., Cleveland, Ohio
Robbins & Myers, 1345 Lagonda Ave., Springfield, Ohio
Speedway Mfg. Company, 1834 South 52d Ave., Cicero, Ill.
Star Electric Motor Company, Grove St. & Bloomfield Ave., Bloomfield, N. J.
Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles, Cal.
Sturtevant Company; B. F., Hyde Park, Boston, Mass.
Sunlight Electric Company, Div. General Motors, Warren, Ohio
Torq Electric Mfg. Company, 6607 Carnegie Ave., Cleveland, Ohio
U. S. Electric Motors, 80 34th St., Brooklyn, N. Y.
U. S. Electrical Motors, Inc., 200 East Slauson Ave., Los Angeles, Cal.
Victor Electric Products, Inc., 2950 Robertson Ave., Cincinnati, Ohio
Wagner Electric Company, 6400 Plymouth Ave., St. Louis, Mo.
Walker-Turner Company, Plainfield, N. J.
Warren Telechron Company, Ashland, Mass.
Wesche Electric Company; B. A., 1628 Vine St., Cincinnati, Ohio
Westinghouse Electric & Mfg. Company, East Pittsburgh, Penn.
Zobell Electric Motor Corp., Garwood, N. J.

Reprints of this section are available at 10 cents each, special price for quantities. Address publisher—PRODUCT ENGINEERING, 330 West 42nd Street, New York (18) N. Y.

INDUSTRY AND SOCIETIES

NEWS • READER LETTERS • MEETINGS

Post-War Automobile Design Will Be Evolutionary

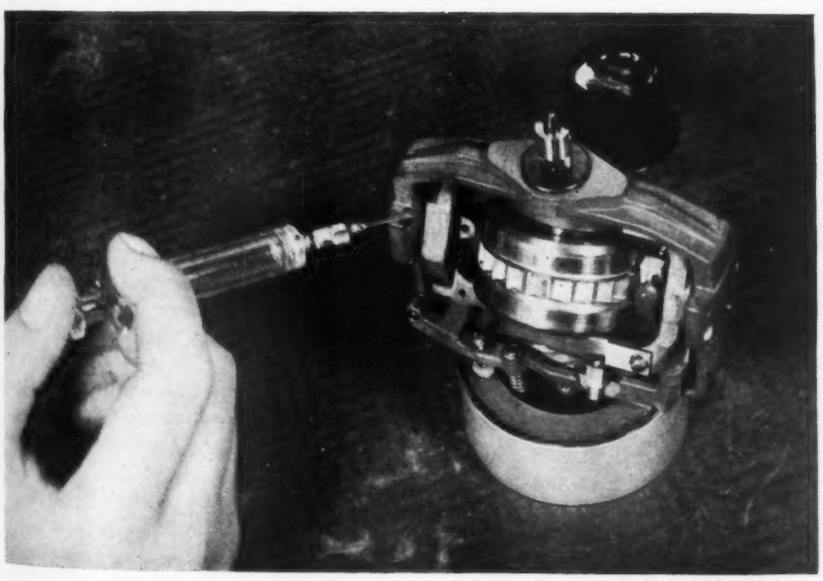
DEPARTURES from current automobile design will not be "radical" in the post-war period, according to an exhaustive survey of engineering opinion presented by Floyd F. Kishline, chief engineer of the Nash Motors Division, Nash-Kelvinator Corp., at a recent meeting of the Metropolitan Section of the Society of Automotive Engineers. Another point brought out was that it will be a matter of years before realities catch up with current "air-brush" stylists' renderings.

Evidence was presented, however, of broad differences of opinion among engineers as to the speed and direction in which design of component automobile parts would progress. The survey on which Mr. Kishline based his report showed special interest in two particular mechanical potentialities—supercharging of automobile engines for greater efficiency and major improvements in torque converting. War production progress has stimulated the hope that an efficient, low-cost, constant-variable transmission can soon be developed for automotive use.

On the marketing side, the survey indicated an expectation that post-war cars will be more, rather than less, expensive than their pre-war predecessors principally because of higher taxes and labor costs. These may well have to be offset by greater efforts toward "economical" rather than "radical" designing. For the present, it was made clear, little concrete work on post-war design is in progress because the engineers involved are fully occupied with war production.

Other interesting results of the survey were an indication of agreement that 60 m.p.h. was a sufficiently high top speed for smaller automobiles and that few engineers expected revolutionary shifts to light metals except for the use of secondary aluminum in engine and accessory parts. Carbon steel seems the most probable metal for the bulk of post-war automobile structural material. Strong interest, but relatively little specific agreement, was reflected by the survey on the substitution of fuel injection for orthodox carburetion and the possible use of air-cooled engines.

Hypodermic Lubricates Small Pivots



Electric Auto-Lite Co.

Pivots on directional gyros, major components of the "automatic pilot" used on airplanes, are so accurate and require such a small amount of lubricant, that it is necessary to oil them with a hypodermic syringe.

Welding Stainless Steel Shown in Film

AS AN AID in the teaching of how to weld stainless steels a 16-mm. color sound film has been prepared by the Allegheny Ludlum Steel Corporation. Of possible interest to engineers is the magnified close-ups of the arc at work, showing the action of the protective flux and the melting of the metal rod. This two-reel film, which takes about 25 min. to run, is available without charge for showing before interested groups. Requests should be addressed to Allegheny Ludlum Steel Corporation, Brackenridge, Pa.

C.E.D. Headquarters Moved to New York

MAIN OFFICES of the Committee for Economic Development, were moved to 285 Madison Ave., New York, N. Y. on Nov. 1. This was done to help re-

lieve crowded conditions in Washington, where the organization previously had its headquarters in the Department of Commerce Building. In announcing the move, John Fennelly, executive director, said:

"Since its formation, the C.E.D. has had office space in the Department of Commerce Building which was made available by the Secretary of Commerce because he felt that the work which the C.E.D. is carrying on is of vital importance to the people of the United States. We are not an official nor even a semi-official agency of the government, however, and it seems only fair for us to move to our own offices. Our work is carried on in every community in the country, completely independent of government; therefore, we feel that with conditions as crowded as they are here in Washington, we ought to move to New York."

Some office space will be kept in the Department of Commerce Building for use of certain research workers and staff members who are obliged to spend some of their time in Washington.

ANNUAL INDEX

The annual index of the editorial content of Product Engineering for 1943 is available to subscribers without charge. Requests should be forwarded to the Editor, Product Engineering, 330 W. 42nd Street, New York 18, N. Y.

Discussions and Comments From Readers

IMPROVED DESIGN OF BEARING CHAMBER SEAL

To the Editor:

Referring to your October number, page 663, entitled "Causes and Cures," the first item discusses the possibility of eliminating leakage between the flange of stuffing box and bearing housing. The original design and the improved design illustrated are both incorrectly shown as to the possibility of eliminating the difficulty. It is suggested that standard conventional bearing practice be exercised, and that is to eliminate the shims and lead wire, as shown in the original design and allow the outer race to float by having a 0.005- to 0.010-in. positive clearance. Then the stuffing box with the integrally cast prongs can be used. A paper gasket inserted between the stuffing-box flange and housing, in place of the lead wire shown in illustration, will give a positive seal against leakage. This suggestion is standard conventional practice, when the inner race of a bearing is held rigidly to the shaft.

—L. F. WICKMAN
Oakland, Calif.

ERROR NOTED IN 1941 REFERENCE BOOK SHEET

To the Editor:

Recently we had occasion to make use of the Reference Book Sheet in your July, 1941, issue referring to the design of unfired pressure vessels. On sheet 3, page 393, giving the thickness for dished heads, we find that the letters A1 and A2 should be interchanged, as well as letters B1 and B2. Possibly it has been called to your attention before, but this is the first time we have run across it and think that this sheet should be corrected. We have calculated several heads and find the table to be correct after the above changes are made.

—B. P. RAPLEY, *Chief Engineer*
International Petroleum Co.
Talara, Peru

WRONG DIMENSION GIVEN IN MODIFIED THREAD ARTICLE

In Fig. 1 of the article "Modified Standard Thread for Primary Aircraft Structures," PRODUCT ENGINEERING, Oct., 1943, p. 641, the dimension $5/6H$ should be taken from the crest of the screw thread to the crest of the nut thread instead of from the crest of the screw thread to the bottom of the screw thread. Also, the symbol R_8 should be used in place of R_5 for the root radius of the screw thread.

PROBLEM ON BEARING LOAD ANSWERED BY READERS

To the Editor:

H. J. Smith's calculation for load bearing, PRODUCT ENGINEERING, October, 1943, page 674, is correct with the exception that he should use $D \times L$. The reason for this is that when the bearings have worn and the rotors move toward the suction port there will be clearance on the discharge side of the rotors and pressure will be applied to the full rotor face. The pump will still operate since there will be a full seal on the suction side of the rotors.

—H. M. KUPPINGER
Pump Engineer
Schutte & Koerting Co.

To the Editor:

I should like to submit a method of calculating bearing loads on rotary gear pumps, for the benefit of H. J. Smith, whose problem was published in the October issue of PRODUCT ENGINEERING, page 674. The load on the bearing of a rotary gear pump is made up of two factors: First, the hydraulic load, and second, the mechanical load. The hydraulic load is a direct function of the pump discharge pressure and is taken as the product of the pressure and the projected area of one gear. So far, Mr. Smith is quite correct. The hydraulic load per bearing is then

$$\frac{2.3125 \times 2.5 \times 800}{2 \times 2} = 1{,}160 \text{ lb.} = L_1$$

The mechanical load on the bearing is calculated the same as for a pair of spur gears. This mechanical load is expressed as follows:

where $L_2 = P^2 + S^2$

$$P = \frac{Q}{r}$$

$$S = P \tan \alpha$$

$$Q = \text{torque input} = \frac{\text{hp.} \times 63{,}025}{N}$$

in in. lb.

Hp. = actual hp. required to drive pump at given load

N = r.p.m. of driving gear

r = pitch radius of gear in inches

α = tooth pressure angle of gear

P = tangential force

$S = P \tan \alpha$

Total load per bearing will be

$$L_1 + \frac{L_2}{4}$$

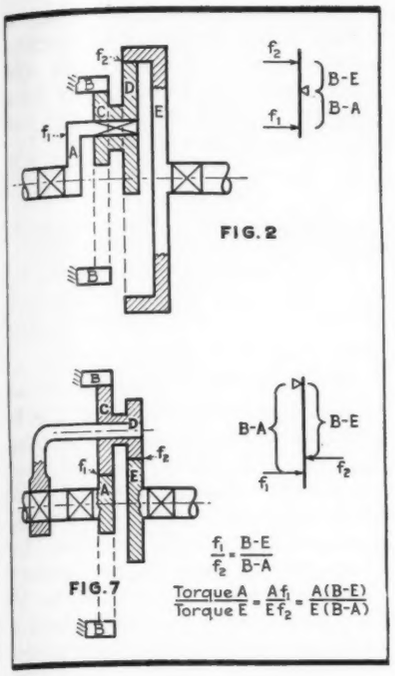
Since none of the conditions as to horsepower, speed, pitch of gears or pitch diameter are stated in Mr. Smith's problem, we cannot complete the calculations. I have used the foregoing method for a number of years with excellent results. Continuous check on performance has verified the results within very close limits.

—H. F. OWEN
Associate Professor
Industrial Engineering
Purdue University

ANALYZING FORCE AND TORQUE RELATIONS

To the Editor:

With reference to Mr. M. F. Spotts' analysis of epicyclic gear trains in PRODUCT ENGINEERING, September,



page 609, I would like to submit a formula which is developed by a method which I call "instantaneous centers" and which is applicable without change to the six gear combinations shown in Mr. Spotts' analysis.

In connection with Fig. 1 as printed, I believe that the quantity N_bN_e should be N_bN_d.

In my method the gears are considered as remaining stationary and the ratio of torques of input and output shaft is obtained by the consideration of the ratio of forces and lever arms. The attached sketch shows this method applied to Fig. 2, as shown in Mr. Spotts' article, and to another arrangement designated as Fig. 7. This same relation of input and output torque involving members *A, B* and *E*, using Mr. Spotts' lettering of parts, can be shown to apply to the gear trains in the other figures. The ratio of the input to output speed is, of course, the reciprocal of the torque ratio. A positive result indicates the input and output shafts rotate in the same direction—a negative result in opposite directions.

It is believed that this method, where it can be applied, gives a simplified procedure of analyzing and evaluating the force and torque relations.

—W. W. WARNER
Fractional Hp. Motor Section
General Electric Co.

CORRECTION NOTED IN TUBING ARTICLE

In the table of properties of thermoplastic materials in the article on plastic tubing, published in PRODUCT ENGINEERING for July, 1943, page 440, the range of dielectric constant for vinylidene chloride was given as 0.03-5.00 instead of 3.00-5.00, the accepted range of values for this property.

LOW-TEMPERATURE STEEL CORRECTION

The effect of liquid quench on low-temperature strength of NE 8630 steel, charted on page 8, Steel Castings insert, November, 1943, PRODUCT ENGINEERING applies to A.S.T.M. grades in specification A 148-42.

Activities Among Technical Societies

FINE-PITCH GEARING STANDARD FEATURES A.G.M.A. MEETING

Adoption as a tentative standard of the standard for fine-pitch gearing developed by a committee under the chairmanship of L. D. Martin, Eastman Kodak Company, was one of the highlights of the three-day semi-annual meeting of the American Gear Manufacturers Association held October 25-27 at the Edgewater Beach Hotel, Chicago, Ill. This standard is presented in full on pages 823 to 828 of this number of PRODUCT ENGINEERING.

Considerable progress was reported in the compiling of new standards under the direction of S. L. Crawshaw, Western Gear Works, chairman of the general standards committee and in bringing existing standards up-to-date by the technical editing committee under the leadership of W. P. Schmitter, Falk Corporation.

Business phases of the industry, including termination of war contracts, were covered by the general commercial committee under the chairmanship of W. L. Schneider, Falk Corporation. The largest attendance in the association's history was called to order by President Russell C. Ball, president, Philadelphia Gear Works.

LEAD SILVER SOLDERS FOUND SAFE FOR CANS

Extensive research carried out by the War Metallurgy Committee of the National Academy of Sciences indicates that lead-silver substitute solders used on food cans do not involve a health hazard. This conclusion is reached in a report entitled, "Safe Substitute Solder for Food Cans." The report also points out that the substitute solder is no more expensive in raw material cost than the lead-tin solder previously used.

CORRONIZING PROCESS IMPROVEMENTS DESCRIBED

Simplified application, increased protection and reduced cost were described as improvements in the Corronizing process by Walter Munger, sales manager, Corronizing Div., Standard Steel Spring Company, during the National Metal Congress. Mr. Munger indicated that the process would be available immediately to industry when restrictions on critical materials are released.

The process, Mr. Munger stated, involves the electroplating of thin layers of corrosion-resistant metals and alloys on metal-base stock. These metals and alloys are nickel and zinc, and nickel and tin, the basic application of both coatings being nearly identical. Since the Standard Steel Spring Company owns the Corronizing process, but does not produce Corronized products, users will be licensed.

Do You Know That—

INTRICATE CELLULAR CONSTRUCTION in plastic parts is now possible with a method of forming cavities by using sand cores with the sand wrapped in wax paper to provide the surface necessary for contact wth the plastic. (34)

CONVERISON TO WOOD of products previously manufactured of metal will release 5,000,000 tons of metal for war service during 1943. (35)

ROTORS of aircraft gyroscope instruments must be able to run for hundreds of hours at 40,000 r.p.m. (36)

LIFE OF BRUSHES in aircraft generators used at altitudes over 30,000 ft. has been increased more than 50 times by development of a special grade of brush for high altitude flying and providing proper ventilation. (37)

GREATER ACCURACY and results that are easier to read are the advantages of a "hydraulic break machine" operated by water power and used for testing the strength of plywood and glued joints. (38)

New Books

Mechanics of Materials

S. G. George *and* E. W. Rettger, *revised by* E. V. Howell. 491 *pages*, 6x9 *in., blue clothboard covers. Published by McGraw-Hill Publishing Co.*, 330 *W. 42nd St., New York, N. Y. Price* $3.75.

In this second edition no changes have been made in the previous presentation or topics. But the order of the chapters on the theory of beams has been rearranged to obtain better sequence. Problems have been rewritten to include new data. The text covers thoroughly the generally accepted divisions of mechanics of materials such as stresses, strains, riveted joints, torsion, beams and columns. Numerous problems are included for practice in applying procedures and formulas developed in the text. The discussions in the book are supplemented with more line drawings than are usually employed.

Letters and Lettering

Paul Carlyle, Guy Oring *and* H. S. Richland. 159 *pages*, 10x8 *in., tan clothboard covers. Published by McGraw-Hill Book Co.*, 330 *W. 42nd St., New York, N. Y. Price* $4.

Engineers who wish to achieve various effects in lettering can get many good ideas for individual style from this book. Fifteen basic alphabets, each representing a different style, are presented. Other examples are given of old fashioned, exotic, modern script and expressive lettering. The introduction is a short course in lettering.

Boot Straps

Tom M. Girdler. 471 *pages*, 5⅝x 8¼ *in., blue clothboard covers. Published by Charles Scribner's Sons*, 597 *Fifth Ave., New York* 16, *N. Y. Price* $3.

This is the autobiography of the chairman of the boards of Republic Steel Corporation and Consolidated Vultee Aircraft Corporation. For many readers it will make as exciting reading as a best-seller novel because it is the absorbing story of a man who grew up with the steel industry. Mr. Girdler is a mechanical engineer most of whose working life has been concerned with industrial management. For this reason alone his life story should be of special interest to engineers. Further, however, he is greatly concerned about the future of this country if inventiveness and technical development are hampered by legislation. Anyone who reads this book cannot help but be impressed by Mr. Girdler's sincerity in his remarks about irresponsible labor union leaders and politicians. The philosophy expressed in the book is that of a man who has been in close contact with all sides of our present-day industrial economy and who, because of his successful experience, is eminently qualified to comment on it.

Elements of Mechanical Vibration

C. R. Freberg *and* E. N. Kemler. 185 *pages*, 5½x8¼ *in., black clothboard covers. Published by John Wiley & Sons, Inc.*, 440 *Fourth Ave., New York, N. Y. Price* $3.

A clear discussion of the elementary phases of vibrations as they occur in various mechanical systems. The methods of solution involve the simpler forms of differential equations, approximate methods, and the mobility method; all of which can be understood by engineers without training in advanced mathematics. The text material deals with undamped and damped vibration isolation and absorption, equivalent systems, mobility method, and mechanical and electrical models of vibration systems. Practice problems are included. An appendix of eleven pages contains pertinent reference material.

Industrial Radiology

Ancel St. John *and* Herbert R. Isenburger. *Second edition.* 6x9 *in.*, 298 *pages, blue clothboard covers. Published by John Wiley & Sons, Inc.*, 440 *Fourth Ave., New York, N. Y. Price* $4.

The first edition of this book appeared under the title "Industrial Radiography." The change in title has been brought about by the fact that visual inspection of materials has now come of age. The present volume deals with the field of radiology as a nondestructive method of inspection. Procedures in making inspections and operation of equipment are fully described, as well as the analysis of results. Many applications of interest to engineers include the radiography of large castings and forgings, welded vessels and structures, and numerous small objects. Rules, tables and charts make up an unusually large appendix section. Bibliography lists more than 1,300 references.

Engineering Mechanics

F. L. Singer, 482 *pages*, 6¼x9¼ *in., blue clothboard covers. Published by Harper & Bros.*, 49 *East 33rd St., New York, N. Y. Price* $4.

The fundamental principles of the subject of mechanics and their applications in the solution of engineering problems are presented clearly and graphically. Analytical methods are combined with graphical methods throughout the book. Equations are interpreted in terms of their geometrical equivalents. Conforming to the formal study of mechanics the book is composed of two divisions—statics and dynamics. Part I deals with principles, force systems, structures, friction, centroids and centers of gravity, and moments of inertia. Part II deals with principles, motion, work, energy, impulse, momentum, mechanical vibrations, and graphic methods. For practice in applying the principles and methods set forth the text is supplemented with numerous problems.

Complex Variable And Operational Calculus With Technical Applications

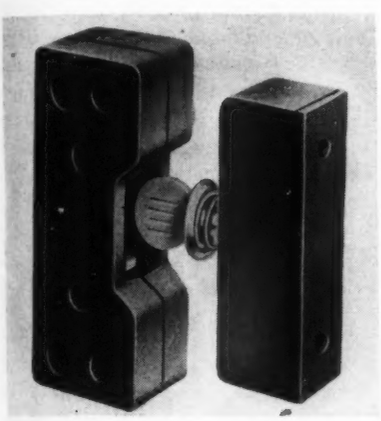
N. W. McLachlan. 355 *pages*, 5½ x8½ *in., black clothboard covers. Published by Macmillan Co.*, 60 *Fifth Ave., New York, N. Y. Price* $4.75.

This modern treatment of the so-called operational method is written primarily for those who use higher mathematics to solve technical problems of various kinds. The book is divided into four main parts: complex variable, operational calculus, technical applications and examples, and appendices. Part I provides the reader with an exposition of the theory of functions of a complex variable. Part II develops operational calculus using complex integration and is based on the Mellin inversion theorem, Part III deals with technical applications of the method to many engineering problems, some of which relate to airplane stability, annealing of steel rods, electrical circuits, radio broadcasting, torsional oscillations, and transmission of heat in solid bodies. More than 200 references are listed in an excellent bibliography.

NEW MATERIALS AND PARTS

Door Interlock Switch

Designed as an emergency device to interrupt control circuits when access doors are opened while the power is on, a door interlock switch has a carrying capacity of 10 amp., 110 or 220 volts, a.c. or d.c., and an emergency opening capacity of a.c. 7½



amp., 110 or 220 volts; d.c. on low inductive circuits 5 amps., 125 volts; and 2½ amp., 250 volts. Specialty Div., Electronics Dept., General Electric Co., Schenectady, N. Y.

Hose Clamps

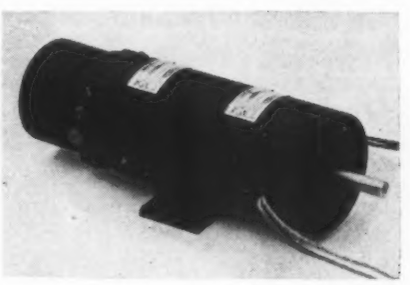
All sizes of standard aircraft hose from ¼-in. up to 4 in. inside diameter are now included in the Aero-Seal line of hose clamps. New additions to the line are Models M-6 and M-10 for hose sizes from ¼- to ¾-in., inclusive. The former is designed for ¼-, ⅜- and ½-in. hose, and the latter for ⅝- and ¾-in. hose. If necessary, the M-10 clamps can be used on all five of these sizes by using the extra take-up in the band. This band is a spring steel strip perforated to correspond with the teeth of a worm gear. It is drawn through the housing by a worm thumb screw, which provides rapid action in tightening the clamps. Since the perforations in the band extend for nearly 3½ in., the clamps may be taken up 1 in. on diameter in the larger sizes. Aircraft Standard Parts Co., 1711 19th Ave., Rockford, Ill.

Emulsion Cleaner

Rapid removal of oil, grease and solid dirt without attacking such base metals as zinc, aluminum, brass, lead and steel is provided by an emulsion cleaner. Use of this cleaner is said to result in more adherent, brighter, and less porous electro-deposits, and more adherent organic finishes. The work is dipped in the cleaner and then rinsed in running cold water, which emulsifies the cleaner along with the grime. This is shown in the accompanying illustration. A short immersion in an alkaline cleaner prepares the work for finishing. The cleaner has high penetrating power and emulsifiability, and rinses rapidly and completely. Its flash point is above 100 deg. F. and there is no strong disagreeable odor. It is also available in a concentrated form which, when mixed with solvent naphthas can be used in the same manner as the cleaner. Enthone Co., 442 Elm St., New Haven, Conn.

Motor Generator

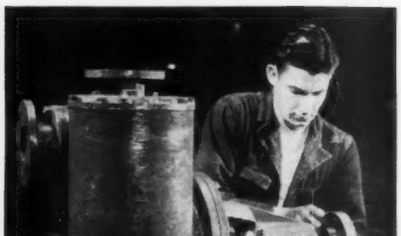
Speed control within 1 percent for 25 percent variation in output or load is claimed for the Model L-32 motor generator. It operates on 6 volts d.c. input and 12, 24 or 115 volts d.c. input units are available. The generator delivers 27 volts, 2 phase, a.c. at 2,400 r.p.m. The 1-, 2- or 3-phase, a.c. output varies with the speed. The



standard model, housed in black synthetic-enameled aluminum, includes speed regulator and resistance. A speed governor is optional. Length is 6½ in., diameter 2 in., and weight 32 oz. Unit is equipped with a single $\frac{5}{16}$-in. shaft with a 1-in. shaft extension from the front of the case. Electric Indicator Co., 110 Parker Ave., Stamford, Conn.

Self-Priming Pump

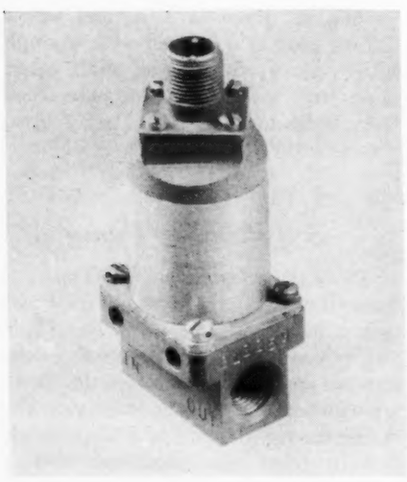
Distinctive feature of the Type AO self-priming pump is an improved automatically controlled valve. Priming is accomplished as a result of the motion of the water through the pump runner and the volute passage. The water carries behind it a slug of air which draws air from the suction



passage through the impeller and out through the priming chamber. This action lifts the column of air in the suction line and achieves the same results as would a separate vacuum pump. The priming valve closes slowly during this process, acting against a spring tension which governs the rate of priming, and the static height of the priming friction lift. The impeller has a thick vane with rounded inlet edges, permitting the passage of stringy materials and fairly large solids. Although only 2-in. and 3-in. sizes are available at the present time, it is planned to broaden this line to include 1- to 6-in. size pumps. Capacities will range from 1,400 gal. per min. to heads of 100 ft. or over. Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Lightweight Shut-Off Valve

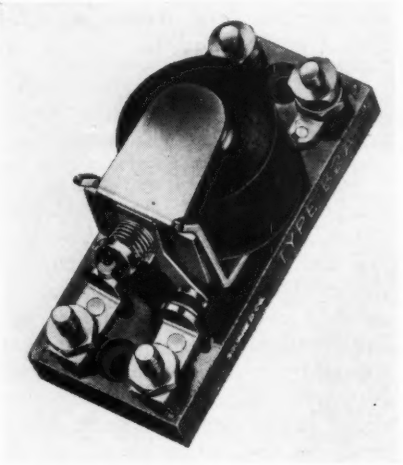
Operated by a solenoid, a fluid shut-off valve that weighs 6.96 oz. has a Dural body, is equipped with standard AN 3102-8S-1P receptacle and is available in port sizes, for $\frac{1}{8}$-in. pipe thread or $\frac{1}{4}$-in. tube fittings. Units are available for working pressures of 50 to 250 lb. per sq.in. The valve is normally closed. Installation may be



planned for any operating position. Current required is 0.25 amp. at 24 volt d.c. Although the unit was designed for remote control of anti-icing fluid flow to the parts of an airplane that are subject to ice accumulations, it is adaptable for other liquid control applications. Adel Precision Products Corp., Burbank, Calif.

Aircraft Contactor

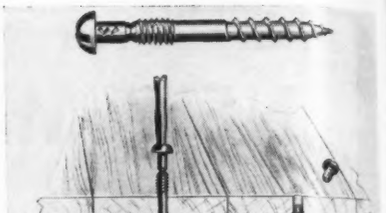
Supplementing the Class 9350 aircraft contactor line which has included 50-, 100- and 200-amp. sizes is a 25-amp. size, known as type B2A, manufactured to meet Army Air Forces Specification No. 94-32185D. This unit can be used for remote control of d.c. motors or as a relay in gunfire, lighting or communication circuits. Weight is 7 oz. and rating 25 amp. continuous duty for potentials up to 29 volts d.c. The contactor will withstand acceleration forces up



to 10 G. or vibration conditions as severe as 55 cycles per sec. at $\frac{1}{8}$ in. excursion. Operating temperature range is from —65 deg. F. to 160 deg. F. and temperature extremes of —75 deg. F. and 200 deg. F. do not cause damage. Square D Co., 4041 N. Richards St., Milwaukee 12, Wis.

Patented Screw

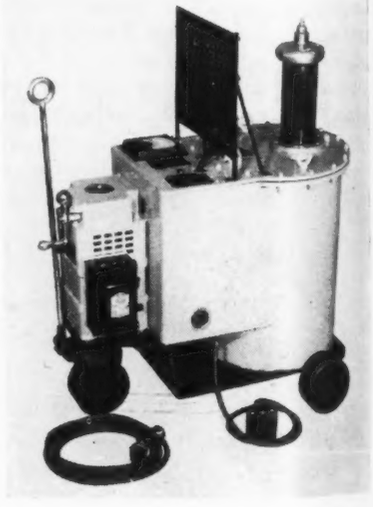
Two threads of different pitch on the same shank form the No-Slip screw. Each turn of the screw brings together the materials being fastened by an amount equal to the difference between the pitches of these threads. For installing the screw, a small hole is drilled to a depth equal to about three-quarters of the length of the screw, which is then inserted. The coarse thread first passes through the



upper and then into the lower of the two sections to be joined. The slightly larger fine thread begins to engage the upper section and as the threads engage the material the difference in pitch causes the two sections to be pulled together until they are tightly joined. The screw is then broken off at the groove just above the fine thread. When properly installed this breaking-off point is always below the surface of the material and the resulting hole can be easily filled. Wil-Son Mfg. Corp., 152 W. Erie St., Chicago, Ill.

Portable Test Set

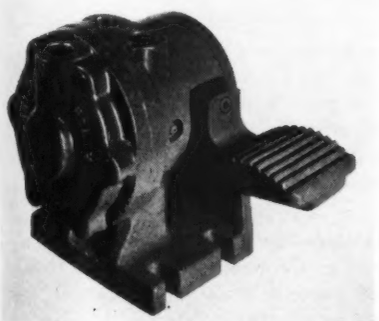
For testing electrical apparatus or insulating materials up to 50,000 volts, a portable test set has been announced for use on single-phase, 115- or 230-volt, 50- or 60-cycle circuits. The unit combines an oil-insulated testing set, an accurate indicating voltmeter, a voltmeter selector switch and complete control equipment such as air circuit breaker, line switch, foot switch and induction voltage regulator. A screened safety guard separates the operator and the high-voltage bushing.



and a red light warns the operator when the set is energized. The instrument has a large dial with a double scale—one for voltages up to 25 kv., and the other for voltages from 25 to 50 kv. The meter is connected to a voltmeter coil wound on the main transformer. The three-wheel truck on which the set is mounted is provided with roller-bearing mounted wheels and a ball-bearing mounted swivel joint for the front wheel. General Electric Co., Schenectady, N. Y.

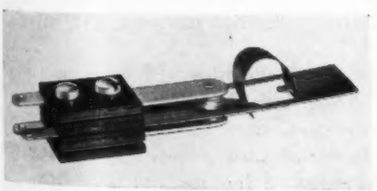
Foot-Operating Valve

Designed for general use on all types of pneumatic equipment is a disk-type, foot-operating valve made in sizes from ¼- to ½-in. The pedal is easy to operate and is returned to neutral by a spring. When the pedal is depressed and the foot removed, the pedal returns to neutral, but the work is held until the pedal is again depressed. Anker-Holth Mfg. Co., 332 S. Michigan Ave., Chicago 4, Ill.



Open-Blade Snap Switch

Designed for use with various relays and contactors is an open-blade snap switch that operates with less than 6 oz. pressure by means of a patented rolling spring. Consequently, smaller coils can be used in relays incorporating this development. Fast action minimizes contact burning. The unit is designed to permit pretravel and overtravel. It has a rating of 15 amp. at 125 volts a.c. Overall size is 3⅞x1⅛x½ in. It is available in single-pole, single- or double-throw, set and return types. Acro Electric Co., 1309 Superior Ave., Cleveland, Ohio.



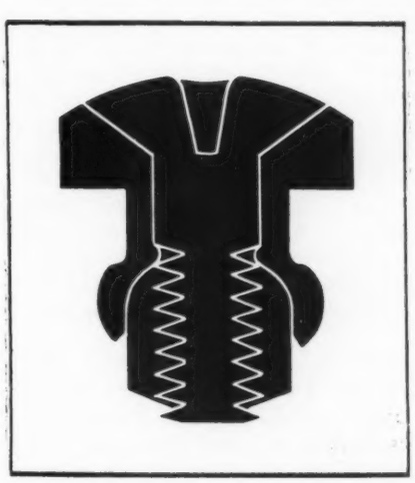
Watertight Lamp Holder

Rated 660 watts at 250 volts is the Woodwin watertight lamp holder, known as No. 861, for marine service. It is molded of low moisture-absorption composition material and has

double contact screw terminals on each side to eliminate the necessity of soldering and taping wire joints in the box. It has a diameter of 2¾ in. and a height above the surface mounting of ⅞ in. Four screw-mounting holes are provided on a $2\frac{5}{16}$-in. dia. circle. C. D. Wood Electric Co., 826 Broadway, New York, N. Y.

Blind Rivet

Simplicity is one of the chief features of the Preco blind rivet that is available in either a raised- or flush-head type. It consists of a cadmium-plated steel recessed-head screw, either Phillips or Reed & Prince, inserted in the hollow stem of a high-strength aluminum-alloy rivet and a knurled nut of Dural threaded on the end of the screw. Both rivet sleeve and nut are anodized. Standard shop riveting procedure is followed as to drilling, burring, reaming, gaging and clamping. The rivet is inserted and tightened with a hand ratchet or a power screw driver and a Cleco adapter and finder. Sheets are gripped tightly and the expansion of the rivet sleeve fills the hole. The rivet is unaffected by sudden changes in temperature. Three diameters—⅛, $\frac{5}{32}$ and $\frac{3}{16}$ in.—are available with grip lengths covering the normal range. Shear standard falls within the allowable range of AD rivets. Pacific Railway Equipment Co., 960 E. 61st St., Los Angeles, Calif.

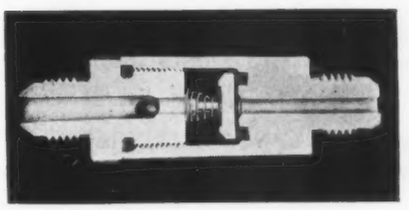


Silver Babbitt

Efforts on the part of the Battelle Memorial Institute to find a substitute for tin-base babbitt that did not contain tin led to the development of silver babbitt, which is essentially silver alloyed with a properly balanced lead-base babbitt. This material is said to be comparable to tin-base babbitts in bondability and corrosion resistance, and retains its hardness at operating temperatures without squeezing out. National Bearing Metals Corp., Dept. C-9, St. Louis, Mo.

Check Valve

Consisting of three parts, the No. 227 check valve is constructed of aluminum alloy throughout except for the O-ring seals which are Army and Navy standard parts. The unit is made to conform to Army and Navy specifications No. AN-V-3 and fits envelope drawing AN-6207. It has a soft self-energizing seal and a metal stop which is unaffected by temperature. Electrol, Inc., 85 Grand St., Kingston, N. Y.



Steel Hardening Solution

No drawing or tempering operations are necessary for hardening steel tools when Steel-Temp hardening solution is used. The process simply involves reheating the work and quenching in the solution. Pearlite texture is said to be improved. Steeltem Chemical Co., 51 E. 42nd St., New York, N. Y.

Manufacturers' Publications

Valves—Darling Valve & Mfg. Co., Williamsport, Pa. Catalog, 324 pages. Complete descriptions and data covering all sizes and types of valves made by the company are presented in such form as to be readily useful to engineers.

Fastening—Bardwell & McAlister, Inc., P. O. Box 1310, Hollywood, Calif. Bulletin No. 2, 4 pages. Explains the Rosán locking system for threaded inserts and studs and illustrates applications of the system.

Felt—American Felt Co., Glenville, Conn. Sample Card. Contains samples of 16 standard grades of Aerofelt for use by designers and engineers interested in the possibilities of felt as an alternate for critical material.

Welding—Allegheny Ludlum Steel Co., 2319 Oliver Bldg., Pittsburgh 22, Pa. Booklet, 64 pages. Describes various methods for welding stainless steel and how these methods differ from those used for welding carbon steel.

Rivets—Cherry Rivet Co., 231 Winston St., Los Angeles 13, Calif. Chart. Special feature in this presentation of essential material on blind-riveting operations is a scale reproduction of countersunk and brazier-head rivets that shows the proper rivet to be used in any thickness of material from 0.030 to 0.391 in.

Coating—American Rolling Mill Co., Middletown, Ohio. Booklet, 24 pages. Data is given on abrasion, friction, weather, chemical, chipping and thermal shock resistance; color range and fastness; and finishes of porcelain enamel. Design factors are discussed and physical properties are compared to other types of coating materials.

Plastics—Boonton Molding Co., Boonton, N. J. Booklet, 72 pages. Brief descriptions of the commonly used plastics and their origin are presented, including a section on parts design and a notable comparison of properties.

Indium—Indium Corp. of America, 1676 Lincoln Ave., Utica, N. Y. Bulletin, 8 pages. Chemical and physical properties are listed and industrial uses are described briefly.

Variable-Speed Pulley—Speedmaster Co., 1213 Thacker St., Des Plaines, Ill. Engineering Manual, 40 pages. Lists and describes all types of Speedmaster pulleys and applications and gives complete engineering data for use of this drive.

Inching Control—Electric Machinery Co., 1331 Tyler St., N. E., Minneapolis, Minn. Publication 170, 4 pages. Details of the E-M Incher are given.

Pumps—Peerless Pump Div., Food Machinery Corp., 301 W. Avenue 26, Los Angeles 31, Calif. Bulletin, 16 pages. Shows uses of the company's pumps in war equipment.

Finishes—American-Marietta Co., 43 E. Ohio St., Chicago 11, Ill. Catalog, 8 pages. Lists the line of Valdura heavy-duty industrial maintenance paints, including application suggestions, product descriptions and technical data.

Abrasive Wheels—Bay State Abrasive Products Co., Westboro, Mass. Bulletin, 4 pages. Describes features of Koolpore grinding wheels.

Cleaning—Oakite Products, Inc., 22 Thames St. New York, N. Y. Manual, 12 pages. Reviews uses for a recently developed acid-type cleaning compound.

Insulator—Electronics Dept., General Electric Co., Schenectady, N. Y. Bulletin, 12 pages. Properties, advantages and applications of Mycalex, high-frequency insulation material available in plates, rods, strips and disks from which parts are machined, and which can be compression molded, are described.

Aluminum—Reynolds Metals Co., 2500 S. Third St., Louisville, Ky. Catalog, 20 pages. Properties and applications of aluminum alloys and data on sheet, strip, wire, rods, bars, tubing and extruded shapes are digested from the standpoint of the product designer.

Relays—Guardian Electric Mfg. Co., 1629 W. Walnut St., Chicago 12, Ill. Bulletin OF112, 2 pages. Thumb-nail descriptions of relay types give contact ratings and combinations, power requirements, size and weight and suggested applications to help in preliminary selection.

Bearings—New Departure Div., General Motors Corp., Bristol, Conn. Booklet, 12 pages. Illustrates various types of ball bearings used in aircraft, tanks, trucks, ships and other war equipment.

Design—Douglas T. Sterling Co., 500 Fifth Ave., New York, N. Y. Bulletin, 8 pages. Describes the organization's facilities for handling problems in the design of new products.

Radiant Energy—Fostoria Pressed Steel Co., Fostoria, Ohio. Bulletin, 8 pages. Illustrates and explains uses in aircraft production of radiant energy near the infra-red part of the spectrum.

Plastics—Continental - Diamond Fibre Co., Newark, Del. Catalog DO43, 42 pages. Properties, uses and manufacture of Dilecto, a laminated phenolic plastic, are described for the benefit of designers and engineers.

Lubrication—Farval Corp., 3293 E. 80th St., Cleveland 4, Ohio. Bulletin 8 pages. The Multival system of lubrication, wherein a group of bearings is lubricated from a central distributing block, is featured.

Variable-Speed Control—Reeves Pulley Co., Columbus, Ind. Catalog G-435, 128 pages. Gives complete descriptions and engineering data for the Reeves variable-speed transmission, Vari-Speed motor pulley and Vari-Speed Motodrive.

Instruments—Rubicon Co., Ridge Ave. and 35th St., Philadelphia, Pa. Bulletin 100, 12 pages. Resistance standards and bridges are described in detail.

Springs—Muehlhausen Spring Corp., Logansport, Ind. Folder, 4 pages. Tabulates significant data for three series of die springs offered by the company.

Pumps—Joshua Hendy Iron Works, Pomona Pump Co. Div., St. Louis, Mo. Catalog 43, 60 pages. Complete information on the various types of Westco industrial pumps is presented.

Laminated Plastics—Richardson Co., Melrose Park, Ill. Booklet, 24 pages. Properties, sizes and grades of available forms and general applications of laminated Insurok are indicated.

Free Enterprise

THE OPPORTUNITY AND OBLIGATION TO COMPETE

WE can be prosperous beyond our dreams—all of us—workers, farmers, and business men—but one of the prerequisites is the self-discipline of accepting competition for ourselves as well as others.

* * *

Free enterprise does not imply the freedom to use any or all means to make a profit. It does not mean the right to monopolize. ***It means the opportunity and obligation to compete.***

Competition requires ***independence of action, free access to the market,*** and ***no large degree of control over the price*** by any buyer or seller. In general, the larger the number of sellers and the more easily buyers can shift from one seller to another, the higher will be the degree of competition (and vice versa for buyers).

But let us not get too academic or go off the deep end. We cannot have perfect competition. We cannot subdivide businesses and labor unions into tiny units to make a multitude of buyers and sellers in each market; we cannot reduce our rich variety of products to a few rigidly standardized items; we cannot educate people to judge quality precisely; we cannot eliminate the costs of bridging space between buyers and sellers. On the other hand, have we gone as far as is practical and desirable in these directions?

We cannot even have a system of highly "sensitive" prices, that is, prices which fluctuate immediately in response to every minor change in demand and supply. This would occur in the dream world of competition-to-the-nth-degree. It cannot occur in the real world, or even in the ideal world of competition best suited to physical facts and human qualities. The economies of large-scale enterprise, the need for adapting products to human wants, the costs of transportation and the costs of issuing and acquiring market information put severe limits on price sensitivity.

Economists tell us that if prices were extremely sensitive, business booms and depressions would be much less severe—provided our stock of money remained fairly constant. But with the somewhat limited degree of sensitivity which is practicable in the economy, price and wage changes cannot prevent severe declines in business activity. ***We cannot count on competition alone to cure depressions.*** We must look mainly to other kinds of measures to prevent mass unemployment of men and machines.

If we cannot have prices which fluctuate with every small change in demand and supply conditions, we can work toward—and achieve, if we really want it—a system in which prices and wages are at least roughly responsive to long-run changes in demand and supply, a system in which most markets are not dominated by individual businesses, groups of businesses, labor unions, or farm organizations, and in which prices and wages are maintained at levels consistent with free access to markets and to jobs.

In any kind of an economic system there must be some means of determining prices, wages, and profits, and of bringing labor and capital into employment in the industry and place where they are most needed. There are two ways to do this: by administrative fiat or by the impersonal processes of the market. The first of these is typical of the totalitarian state; it frequently involves destruction of individual freedom or fumbling mismanagement. During the war all of us have had some experience with patronizing and paternalistic treatment by the state; we have found out what it means to be pushed around by bureaucrats; and we have discovered that the political determination of prices, wages, and profits leads to chaos when self-interest supersedes the fine fever of patriotism—as it eventually does. I do not mean to imply that we can do without controls over prices, production, and distribution in time of war; but I do suggest that we can learn something from their operation. Even with a united national purpose these controls work badly when human abilities are inadequate for the superhuman task, when personal or departmental jealousies crop up among officials, and when pressure groups try to prey on the rest of the public. Every day more Americans are beginning to understand why our forefathers feared the caprice and tyranny of power.

The impersonal processes of the market in determining prices and wages and in allocating productive resources will, in normal times, save us from the fumbling of bureaucrats and from the Babel of confusion, un-

certainty, and annoyance produced by their regulations. But these market processes will not save us from paying toll to those who monopolize and restrict entry to markets or jobs.

If we want an economy in which we are free to try out new ideas, develop new products, and introduce more efficient methods of production, if we want an economy in which there are great opportunities for men of imagination, inventiveness and energy, if we want an economy wide open to progress, then we must have a free field and fair competition for all comers—without collusion as to prices, markets, or production. This is the only basis on which we have a right to demand freedom from governmental regulation for ourselves and on which we can combat monopolistic tendencies in other quarters.

Let us stand squarely for the principles of the anti-trust laws and against all collusion and combination in restraint of trade. Let us insist that the government review with a critical eye every combination and consolidation which might restrict competition. Let us face frankly the problems of economic power arising out of price leadership and encourage every honest effort to find means to deal with them. Let us not shrink from questions as to whether some great aggregations of plants are too large for efficiency, free entry into the industry, and a free price. While we resist the efforts of the Department of Justice to extend the anti-trust laws by far-fetched and distorted interpretation, and while we fight every attempt to use them as a tool of persecution, let us cooperate in sincere efforts to modernize these laws and extend them by specific legislation to monopolistic practices they cannot now reach. I do not have a simple formula for this, but I believe we must try to find one.

We can then, better face the problem of the growing monopoly in labor which is threatening to make the free enterprise system unworkable. Today labor is going through a stage of empire building reminiscent in some ways of a similar stage in business three-quarters of a century ago. Witness the same buccaneering spirit, the same concentration on selfish interests, and the same disregard for the public welfare. Business leaders learned the hard way that the public will eventually rise up against those who prey upon them. Will our labor leaders be wiser? The right to collective bargaining to protect the weak position of the individual employee is one thing—but the grant of unlimited monopoly privilege to combine into a private government which can dictate its own terms to businesses, industries, communities, and even to the government itself, and which can start a wage-price spiral such as to hinder the war effort and make full prosperity impossible in time of peace is something quite different. We need to find a middle way which will prevent employers from exploiting employees but which does not sow the dragon's teeth. The exercise of arbitrary power by labor threatens not only business, but also all workers outside the unions and all those dependent on pensions and savings for their existence, and ultimately, of course, the well being of union workers themselves.

The idea that the labor problem can be solved if great, powerful organizations of employers will sit down with great, powerful organizations of labor is a delusion. If our experience in the N.R.A. and in the war teaches us anything, it is that the best that can be expected in the long run from such a situation is an armed truce with intermittent civil war. And every truce would be a monopolistic arrangement to take advantage of those not members of the great organized groups. Business and labor unions, whenever confronted with postwar readjustments that are unfavorable to them will be sorely tempted to protect their own special interests at the expense of the public. There will be efforts on the part of businesses, abetted by labor unions, to limit productive capacity, to raise tariffs, to obtain subsidies, and to maintain prices at artificially high levels. The unions will oppose labor saving changes and will seek higher wages even in areas and industries of surplus labor. Already demands are emerging for direct joint action by business, labor, and agriculture to solve the transition problems of special concern to them. While these groups should have every opportunity to register their own self-interest, we cannot entrust our fate to decisions made by pressure groups. If experience is any guide, such coalitions will be almost certain to restrict opportunities for progress and expansion, to exploit the public, and ultimately to injure even the businesses, workers, and farmers included in them. We cannot afford a postwar N.R.A. Resort to temporary government regulation in the transition from war to peace may, however, be necessary in cases of great hardship.

We can be prosperous beyond our dreams—all of us—workers, farmers, and business men—but one of the prerequisites is the self-discipline of accepting competition for ourselves as well as others.

President, McGraw-Hill Publishing Company, Inc.

A.G.M.A. Tentative Standard

For 20-Degree Involute Fine-Pitch System for Spur Gears

Approved as a tentative standard by the American Gear Manufacturers Association at the semi-annual meeting in Chicago, October 25–27, 1943.

INTRODUCTION. This standard closely follows the A.G.M.A. and American Standard 20-Degree Full-Depth Involute System for ordinary pitches, with a slight increase in whole depth to allow for the greater proportional clearance necessary in fine-pitch gears.

PRESSURE ANGLE. The 20-degree pressure angle is the most satisfactory selection because a smaller pressure angle would require a greater number of diameter-modifications, and a larger pressure angle would make point widths of generating tools too narrow. Also a larger pressure angle would require closer tolerances on center distance for fine-pitch gears to be assembled without backlash.

BASIC RACK AND STANDARD TOOTH PROPORTIONS. These are shown in Fig. 1 and Table 1. The principal change from the usual 20-degree tooth form is the increase in the clearance to $0.200/P + 0.002$ inches.

PINION ENLARGEMENTS. In order to avoid objectionable undercut in pinions with small numbers of teeth, and also to increase the amount of involute action, pinions with 17 teeth and fewer are enlarged. See Table 2. The diameter increments are the same as in the American Standard for 20-degree Full-Depth teeth. The circular thicknesses listed in Table 2 are those which are obtained by engaging the enlarged pinion with the theoretical rack, Fig. 1, at standard depths.

CENTER DISTANCES. When an enlarged pinion is to be meshed with a gear at the center distance which is standard for the numbers of teeth, the gear diameter must be decreased by the amount of the pinion enlargement. When two enlarged pinions or an enlarged pinion and a standard diameter gear are meshed together, the center distance must be greater than standard.

STANDARD CENTER DISTANCE SYSTEM (Long and Short Addendums). In this system the center distance is made standard for the numbers of teeth, and the pressure angle remains constant. The outside diameter of the gear is decreased the same amount that the pinion diameter is increased. If the number of teeth in the gear is too small, however, undercut will result.

Table 2 lists the decrease in gear diameter, the circular thickness (for no backlash), and the minimum number of teeth to avoid undercut in the gear.

The advantages of this system are:

1—No change in center distance or ratio is required.

2—Operating pressure angle remains standard.

3—Slightly greater contact ratio than is obtained when the center distance is increased.

The disadvantages are:

1—The gears as well as the pinions must be changed from standard dimensions.

2—Pinions having fewer than 18 teeth cannot be satisfactorily meshed together.

3—In most cases where gear trains include idler gears, the Standard Center Distance System cannot be used.

ENLARGED CENTER DISTANCE SYSTEM. When two enlarged pinions, or an enlarged pinion and standard diameter gear, are meshed together, the center distance must be increased. For fine-pitch gears, it is usually satisfactory to increase the center distance by an amount equal to one half of the enlargements. This is an approximation, as theoretically there is a slight increase in backlash.

With an increase of center distance, there is a slight increase of operating pressure angle, which is usually not important.

The advantages of this system are:

1—Only the pinions need be changed from standard dimensions.

2—Pinions having fewer than 18 teeth may engage other pinions in this range.

The disadvantages are:

1—Center distances must be enlarged over standard.

2—The operating pressure angle increases slightly with different combinations of gears and pinions.

3—The contact ratio is slightly smaller than that obtained with the standard center distance system. This consideration is of minor importance as in the worst case the loss is approximately only 6 percent.

TABULATED DIMENSIONS. Standard generating tools (hobs or cutters) are used for gears made to either system.

Table 1 gives the standard tooth proportions and formulas.

Table 2 gives the dimensions of enlarged pinions, the gear dimensions, the recommended minimum number of teeth in the gear (to avoid undercut) for the Standard Center Distance System, and the center-distance increase for the Enlarged Center Distance System.

DATA SHEETS. Supplementing this Standard are five data sheets which give useful information for the designer.

Data Sheet No. 1 gives the theoretical center distance at which two enlarged pinions will engage with no backlash.

Data Sheet No. 2 gives the theoretical backlash obtained with two enlarged pinions.

Data Sheet No. 3 gives the formulas for the calculations on which Data Sheets 1 and 2 are based. The formulas can also be used to obtain similar information when an enlarged pinion is meshed with a standard diameter gear.

Data Sheet No. 4 contains a graph and explanations for finding enlargements for helical pinions.

Data Sheet No. 5 gives the tolerance in outside diameter for fine pitch gears.

FINE PITCH SYSTEM FOR INVOLUTE SPUR GEARS
20 DEGREE BASIC PRESSURE ANGLE

BASIC RACK

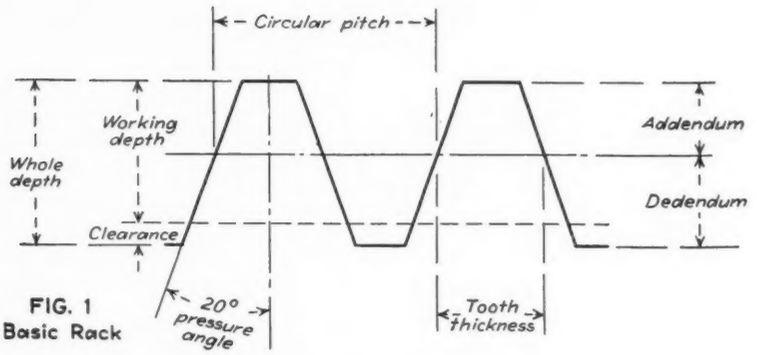


FIG. 1
Basic Rack

Table 1 — Standard Tooth Proportions
Dimensions Are in Inches

Addendum	$\frac{1.000}{P}$	Whole Depth	$\frac{2.200}{P} + 0.002$	Pitch Diameter	$\frac{N}{P}; \frac{n}{P}$
Dedendum	$\frac{1.200}{P} + 0.002$	Clearance	$\frac{0.200}{P} + 0.002$	Outside Diameter*	$\frac{N+2}{P}; \frac{n+2}{P}$
Working Depth	$\frac{2.000}{P}$	Tooth Thickness on Pitch Diameter	$\frac{1.5708}{P}$	Center Distance	$\frac{N+n}{2P}$

N = number of teeth in gear n = number of teeth in pinion P = diametral pitch

**Pinions having 17 or fewer teeth should be enlarged. See Table 2.

Table 2 — 20 Degree Pressure Angle Involute Fine Pitch System for Spur Gears
Dimensions Required When Using Enlarged Pinions

The outside diameters of small pinions are enlarged to avoid undercut. To maintain standard center distances when using enlarged pinions, the mating gear diameters must be decreased by the amount of the pinion enlargement. If mating gears are made with standard tooth proportions, the center distances must be increased as shown below. Tabular values are in inches for 1 *D.P.* For other pitches divide tabular values by the diametral pitch.

	Pinion Dimensions		Standard Center Distance System (Long and Short Addendum) Gear Dimensions			Enlarged Center Distance System Standard Mating Gear Diameter
Number of Teeth	Outside Diameter	Cir. Tooth Thickness at Standard Pitch Diameter	Decrease in Standard Outside Diameter	Cir. Tooth Thickness at Standard Pitch Diameter	Recommended Minimum Number of Teeth	Increase Over Standard Center Distance
10	12.8302	1.8730	0.8302	1.2686	33	0.4151
11	13.7132	1.8304	0.7132	1.3112	30	0.3566
12	14.5963	1.7878	0.5963	1.3538	27	0.2982
13	15.4793	1.7452	0.4793	1.3964	25	0.2397
14	16.3623	1.7027	0.3623	1.4389	23	0.1812
15	17.2453	1.6601	0.2453	1.4815	21	0.1227
16	18.1284	1.6175	0.1284	1.5241	19	0.0642
17	19.0114	1.5749	0.0114	1.5667	18	0.0057

DATA SHEET No. 1
20 Degree Pressure Angle Fine Pitch System

Theoretical center distances at which enlarged pinions will engage with no backlash. Enlargements are in accordance with Table 2. Dimensions are in inches for 1 *D.P.* For other pitches divide tabular values by the diametral pitch.

Number of Teeth	10	11	12	13	14	15	16	17
10	10.6846							
11	11.1461	11.6060						
12	11.6060	12.0644	12.5213					
13	12.0644	12.5213	12.9767	13.4306				
14	12.5214	12.9768	13.4307	13.8833	14.3345			
15	12.9768	13.4307	13.8833	14.3344	14.7842	15.2325		
16	13.4307	13.8833	14.3344	14.7840	15.2324	15.6793	16.1248	
17	13.8833	14.3344	14.7840	15.2323	15.6793	16.1247	16.5687	17.0114

DATA SHEET No. 2
20 Degree Pressure Angle Fine Pitch System

Theoretical backlash obtained when meshing two enlarged pinions. Enlarged center distance system. Dimensions are in inches for 1 *D.P.* For other pitches divide tabular values by the diametral pitch.

Number of Teeth	10	11	12	13	14	15	16	17
10	0.163							
11	0.136	0.112						
12	0.112	0.092	0.074					
13	0.092	0.074	0.058	0.045				
14	0.074	0.058	0.045	0.034	0.024			
15	0.058	0.045	0.034	0.024	0.017	0.011		
16	0.045	0.034	0.024	0.017	0.011	0.006	0.003	
17	0.034	0.024	0.017	0.011	0.006	0.003	0.001	0

DATA SHEET No. 3

Formulas for enlarged center distance and backlash as used in calculating values on Data Sheets No. 1 and 2.

All linear dimensions are in inches.

CASES 1 AND 2. Required: Theoretical center distance for no backlash.

CASE 1. Two enlarged pinions or an enlarged pinion and a standard gear.
Given: Numbers of teeth and circular thicknesses at standard pitch diameters.

$$\text{inv } \varphi_1 = \frac{n(t+T) - \pi d}{d(n+N)} + \text{inv } \varphi \qquad (1)$$

$$C_1 = \left(\frac{d+D}{2}\right)\frac{\cos \varphi}{\cos \varphi_1} \qquad (2)$$

CASE 2. Two identical enlarged pinions.
Given: Number of teeth and circular thickness at standard pitch diameter.

$$\text{inv } \varphi_1 = \frac{t}{d} + \text{inv } \varphi - \frac{\pi}{2n} \qquad (1a)$$

$$C_1 = \frac{d \cos \varphi}{\cos \varphi_1} \qquad (2a)$$

(continued on next page)

DATA SHEET No. 3 (continued)

CASES 3 AND 4. Required: Theoretical backlash at enlarged center distance.

CASE 3. Two enlarged pinions or an enlarged pinion and a standard gear.
Given: Numbers of teeth, circular thicknesses at standard pitch diameters and enlarged center distance.

$$\cos \varphi_1 = \frac{(d+D)\ \cos \varphi}{2\ C_1} \tag{3}$$

$$B_1 = 2C_1 \left[\frac{\pi}{n+N} - \text{inv } \varphi + \text{inv } \varphi_1 \right] - \frac{(t+T)\ \cos \varphi}{\cos \varphi_1} \tag{4}$$

CASE 4. Two identical enlarged pinions.
Given: Number of teeth, circular thickness at standard pitch diameter and enlarged center distance.

$$\cos \varphi_1 = \frac{d \cos \varphi}{C_1} \tag{3a}$$

$$B_1 = 2C_1 \left[\frac{\pi}{2n} - \text{inv } \varphi + \text{inv } \varphi_1 - \frac{t}{d} \right] \tag{4a}$$

NOTATION

n = number of teeth in pinion
N = number of teeth in gear
d = standard pinion pitch diameter
D = standard gear pitch diameter
t = pinion circular thickness at standard pitch diameter
T = gear circular thickness at standard pitch diameter
P = diametral pitch
φ = standard pressure angle (20 deg.)
C_1 = enlarged center distance
φ_1 = pressure angle at enlarged center distance
B_1 = backlash on pitch circles at enlarged center distance

EXAMPLE 1. Case 1. To find theoretical center distance for no backlash, given a 10 tooth pinion and a 30 tooth gear, 10 P and circular thicknesses of 0.1873 and 0.15708, respectively.

$$\text{inv. } \varphi_1 = \frac{10(0.1873 + 0.15708) - 3.1416 \times 1.000}{1.000(10 + 30)} + 0.014904 = 0.022459 \tag{1}$$

$$\varphi_1 = 22.81 \text{ deg.}; \qquad \cos \varphi_1 = 0.92179$$

$$C_1 = \left(\frac{1.000 + 3.000}{2} \right) \frac{0.93969}{0.92179} = 2.0388 \tag{2}$$

EXAMPLE 2. Case 4. To find theoretical backlash, given two 10 tooth pinions, 50 P, 0.03746 circular thickness and 0.2166 center distance.

$$\cos \varphi_1 = \frac{0.2000 \times 0.93969}{0.2166} = 0.86767 \tag{3a}$$

$$\varphi_1 = 29.81 \text{ deg.}; \qquad \text{inv } \varphi_1 = 0.052655$$

$$B_1 = 2 \times 0.2166 \left(\frac{3.1416}{2 \times 10} - 0.014904 + 0.052655 - \frac{0.03746}{0.2000} \right) = 0.0033 \tag{4a}$$

DATA SHEET No. 4

Enlargement of Helical Pinions of 20 Degree Normal Pressure Angle

The enlargement of helical pinions to avoid undercut cannot be tabulated as simply as for spur pinions because of the wide range of helix angles used. It is recommended that helical pinions be enlarged in accordance with the following graph and formulas.

NOTATION

n = number of teeth
P_n = normal diametral pitch
P_t = transverse diametral pitch
ψ = helix angle
d = pitch diameter
d_o = outside diameter
K_h = enlargement of helical pinion for 1 normal D.P. from graph

FORMULAS

$$P_t = P_n \cos \psi \quad (1); \qquad d = \frac{n}{P_t} \quad (2); \qquad d_o = d + \frac{2 + K_h}{P_n} \quad (3)$$

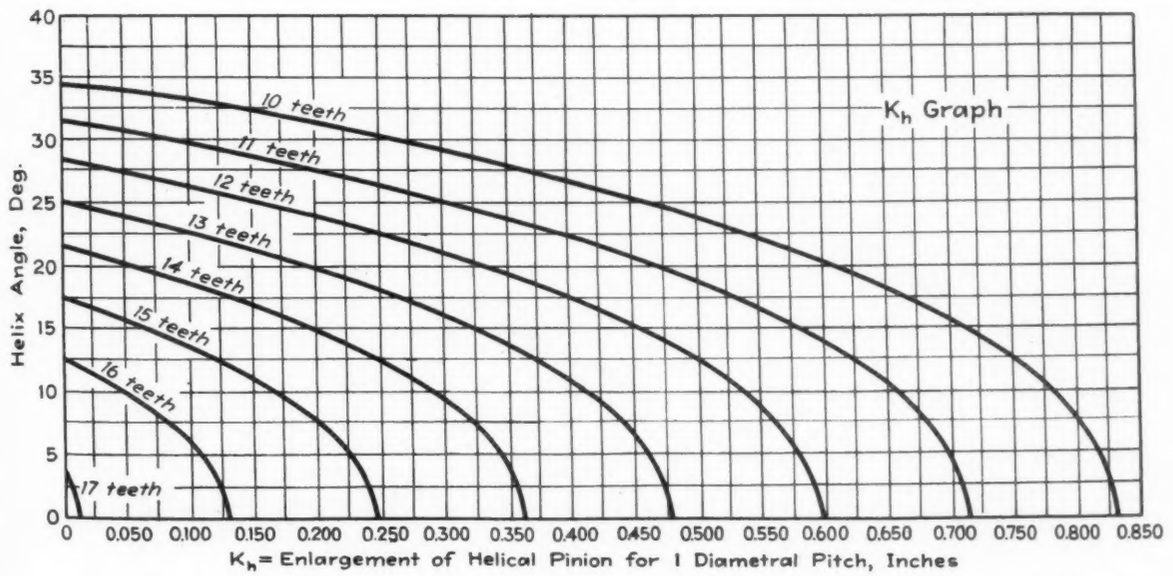
EXAMPLE

Given: 12 teeth, 32 normal D.P., 20 deg. normal pressure angle and 18 deg. helix angle.

$P_t = 32 \times 0.95106 = 30.4339$, (1) $K_h = 0.388$ (from graph)

$d = \frac{12}{30.4339} = 0.3943$ (2) $d_o = 0.3943 + \frac{2 + 0.388}{32} = 0.468$ (3)

When using an enlarged helical pinion, either the mating gear must be reduced in diameter or the center distance must be increased to correspond with the enlargement, as in spur gears.



GRAPH DERIVATION

φ_n = normal pressure angle
φ_t = transverse pressure angle

$$\tan \varphi_t = \frac{\tan \varphi_n}{\cos \psi}$$

K_h = enlargement = $(2 - d_1 \sin^2 \varphi_t)$

d_1 = pitch diameter at 1 D.P. = $\frac{n}{\cos \psi}$

(continued on next page)

DATA SHEET No. 5

Tolerance in Outside Diameter for Fine Pitch Gears

EXPLANATION:

This data sheet shows the permissible O.D. reduction in gears from 30 to 200 D.P. inclusive. The development of this tolerance was based on:

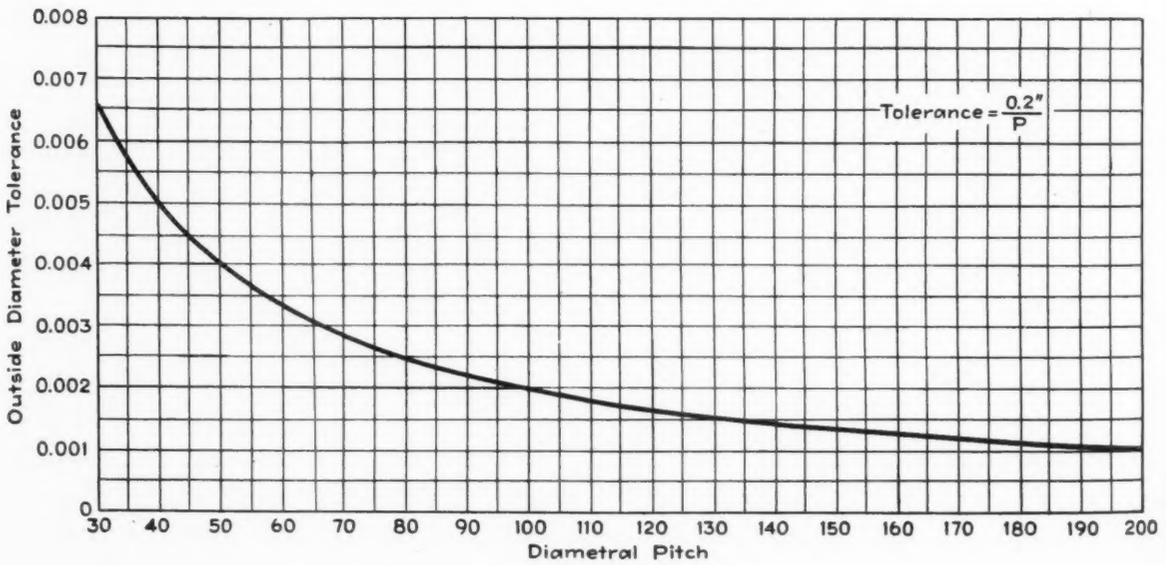
1st—Adequate contact ratio in the critical combinations.

2nd—The minimum practical working tolerance at 200 D.P. which was established as 0.001 in.

The only harmful effect caused by reducing the outside diameter in gears is loss in contact ratio. The outside diameter may be reduced with safety providing a satisfactory contact ratio is maintained. In fine pitch gears the minimum satisfactory contact ratio is considered to be 1.200.

While this data sheet is designed to be used in connection with the 20 degree Involute Fine Pitch Standard, it may be used satisfactorily with any Involute system provided a minimum contact ratio of 1.200 is maintained.

This data sheet covers all cases where the O.D. of a gear or pinion is not used for chucking or assembling purposes.



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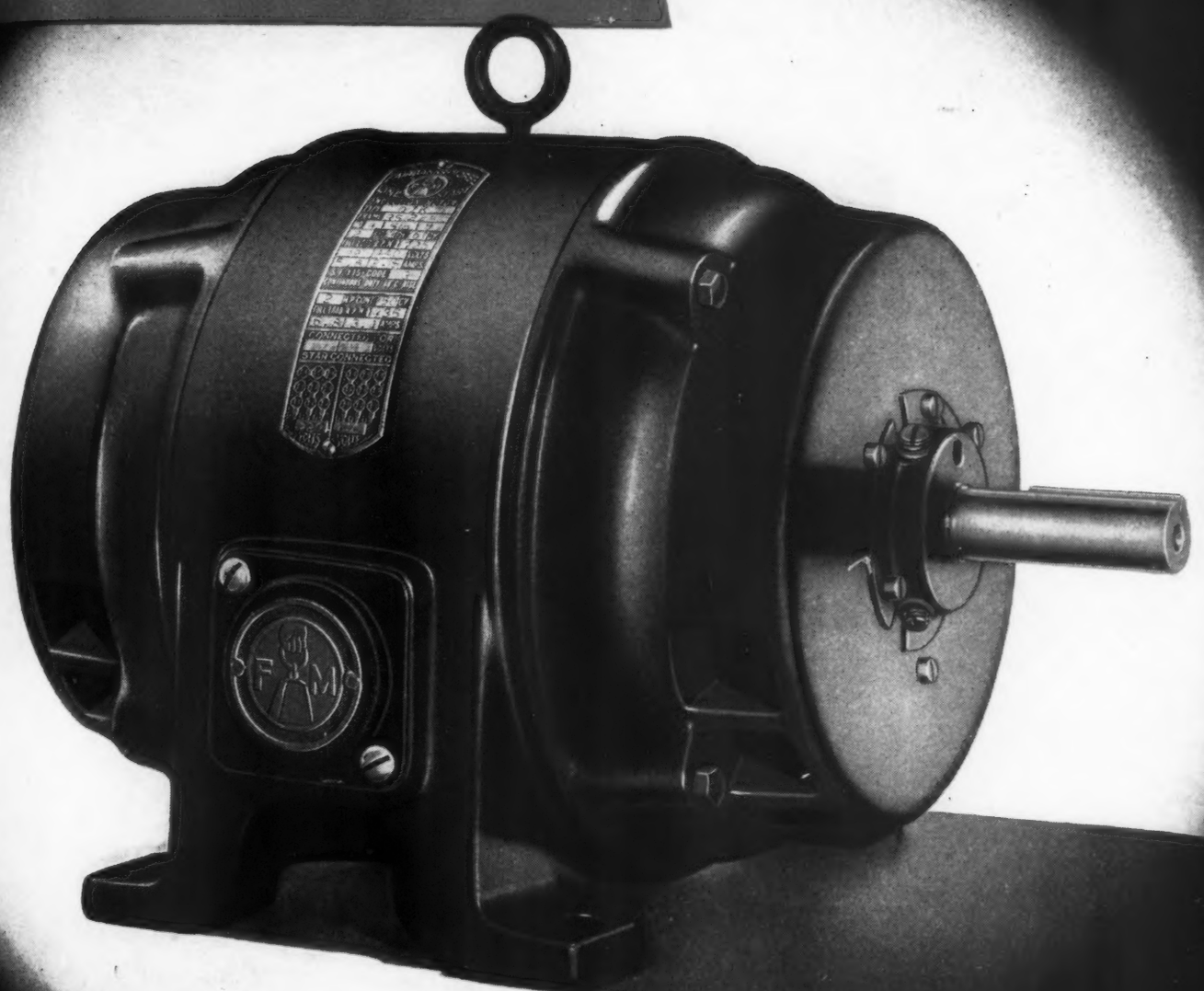

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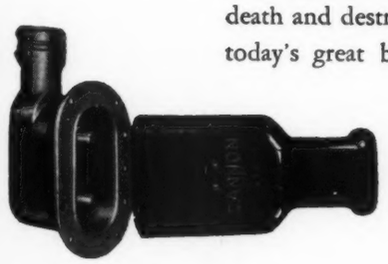

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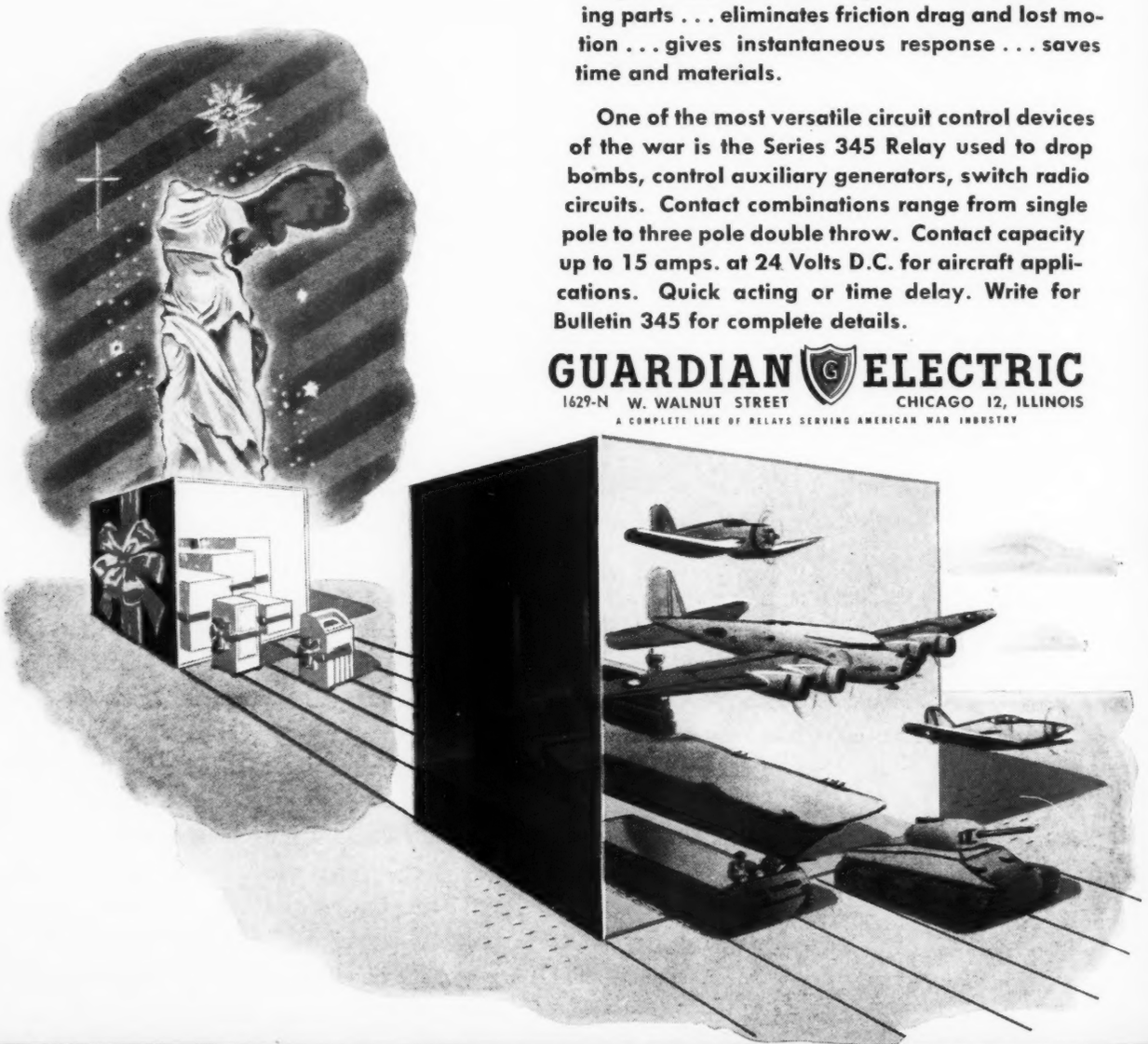

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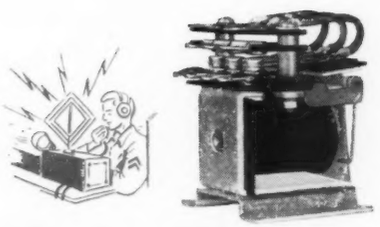

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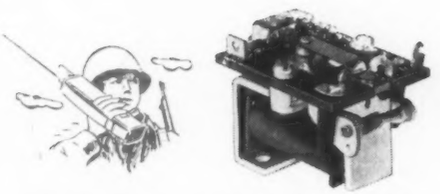

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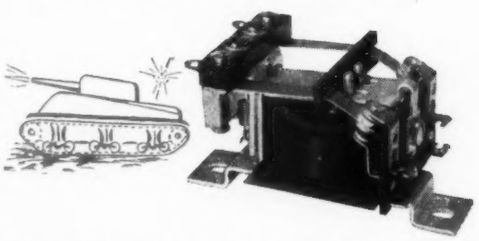

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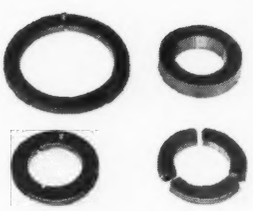

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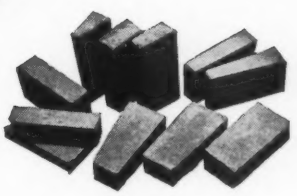

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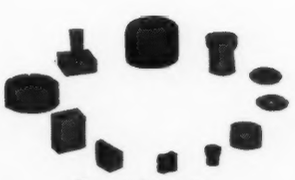

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Radio Condenser Company has been awarded the coveted Army-Navy "E".

Of this award we are proud.

It means we are succeeding in our efforts to supply our armed forces with quality, and quantity, variable air condensers.

Today these condensers are being used exclusively by the branches of our armed forces — land, sea, air.

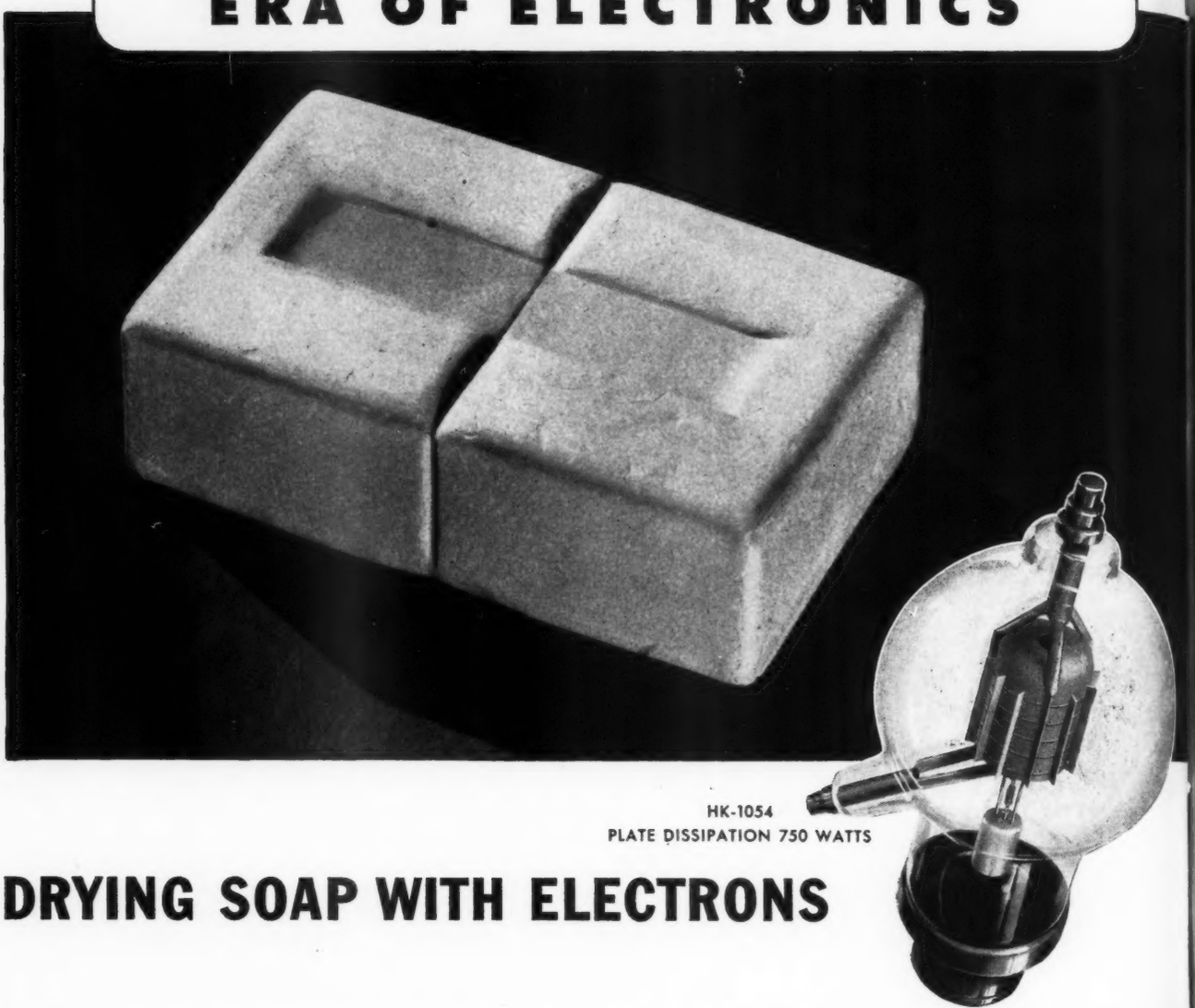
Tomorrow, they will be available to all manufacturers of radio sets.

In planning your post-war radio manufacture, plan to use Radio Condenser Company products: variable air condensers and push button tuning devices.

RADIO CONDENSER CO.
CAMDEN, N. J.
RADIO CONDENSER CO. LTD., TORONTO, CAN.

Your future is linked with the

ERA OF ELECTRONICS



HK-1054
PLATE DISSIPATION 750 WATTS

DRYING SOAP WITH ELECTRONS

The almost instantaneous drying of materials is one of the most promising applications of the electron tube to the speeding of future industrial production.

When soap, dinnerware, cellulose, dyed fabrics, paper, felt and other products which are processed in a damp state, are fed through a high-frequency field, the heat developed *inside the material itself* swiftly drives out unwanted moisture, saving minutes or hours over present drying methods.

There are dozens of applications of electronic drying now being explored which offer great savings in time, space, and equipment. However, full advantage of this relatively new process cannot be taken by industry until the military demand for vacuum tubes and electronic components eases.

Although the engineers of Heintz and Kaufma Ltd. are up to their brows in war work, they ha cheerfully volunteered to answer "after hour your general inquiries about electronic drying And we will be glad to refer you, if you wish, t specialists who can further advise you about elec tronic applications in your particular industry

HEINTZ AND KAUFMAN LTD.
SOUTH SAN FRANCISCO • CALIFORNI

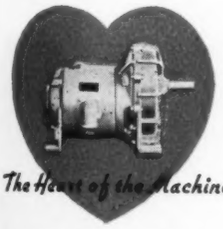
Gammatron Tubes

Gammatrons are built for extra-long life — some have endured 12,000 hours of service. Their tantalum plates and grids allow them to handle heavy overloads without failing, and their unique design results in remarkable efficiency at both radio and very high frequencies.

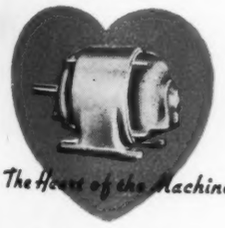
no matter what you are Designing

there's a Motor of Sterling Worth to improve its Perform-ability

STERLING SPEED-TROL MOTORS
A revolutionary design of infinite variable speed, varying from 2:1 to 6:1. 1/4 to 15 H.P.



STERLING SLO-SPEED MOTORS
Direct power applications in a wide variety of speeds and types. 1/4 to 50 H.P. Sound gear engineering.



STERLING STANDARD KLOSD MOTORS
Constant speed integral H.P. general purpose motors in scores of sizes and types. 1/4 to 75 H.P.

Whether it's a machine for immediate war-winning production or the blueprint of a new peacetime product, you will want motive power that is as advanced in design and function as the machine you manufacture. Sterling Motors incorporate all the engineering "know-how" of 43 years' experience in the exclusive development of electric motors and machine design. Each Sterling is engineered and precision-built to meet the individual requirements of its particular application. Sterling Electric Motors are versatile and adaptable and will give your machinery a new kind of perform-ability that will increase its inherent value to you and the user.

Engineering data for specific applications to your machinery on request. Sterling Electric Motors, Inc., New York, Los Angeles. Representatives in principal cities.

CHECK YOUR APPLICATIONS:

- ☐ Agitators
- ☐ Blowers
- ☐ Compressors
- ☐ Conveyors
- ☐ Cookers
- ☐ Cutters
- ☐ Dryers
- ☐ Extractors
- ☐ Fans
- ☐ Feeders
- ☐ Furnaces
- ☐ Grinders
- ☐ Hoists
- ☐ Kilns
- ☐ Lathes
- ☐ Millers
- ☐ Mixers
- ☐ Oil Pumps
- ☐ Ovens
- ☐ Pasteurizers
- ☐ Pressers
- ☐ Pumps
- ☐ Saws
- ☐ Screens
- ☐ Stokers

If the application in which you are interested is not included, note special use on coupon.

STERLING
ELECTRIC MOTORS
for Greater Perform-ability

Sterling Electric Motors, Inc.,
5401 Telegraph Road, Los Angeles 22, California.
Send me complete information on applications checked or for.....

NAME.....

COMPANY.....

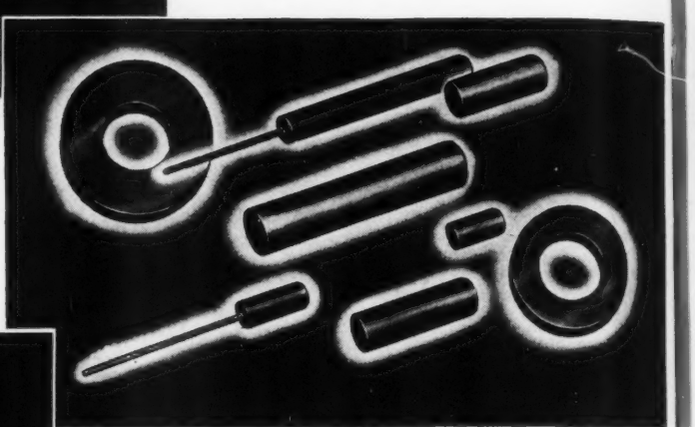
ADDRESS.....

CITY.....

MOLDED CARBONS, GRAPHITES, METALS and COMPOSITIONS

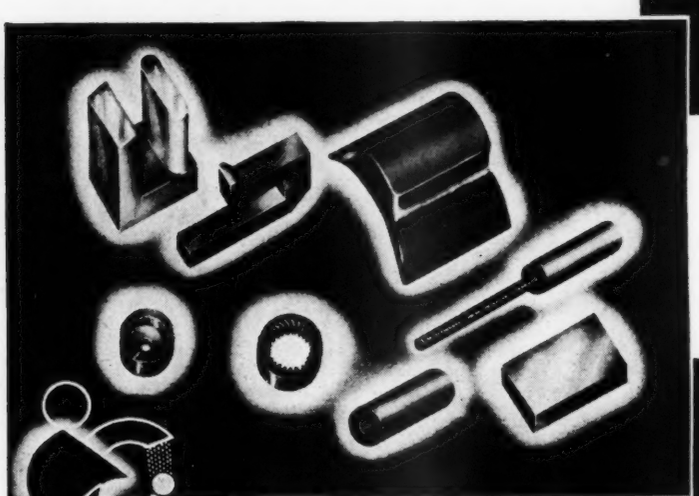
BRUSHES

From the latest, most dependable high-altitude brushes to standard and special types for all rotating electrical equipment, Stackpole produces a complete line for original equipment manufacturers. Stackpole engineers are in constant touch with brush problems and will gladly make recommendations based on this broad, highly-specialized experience.



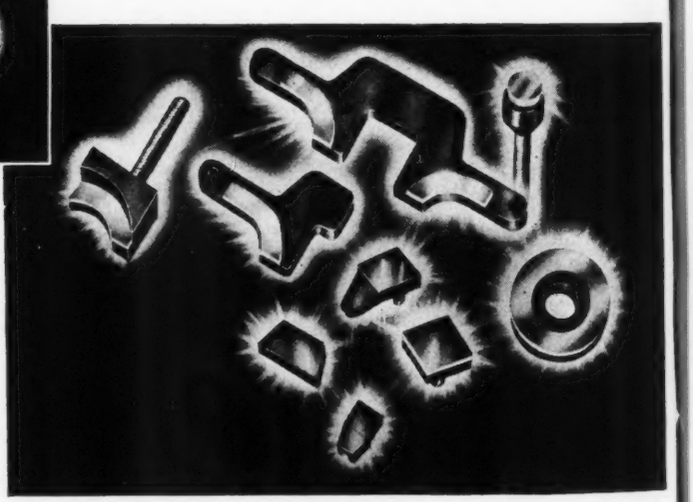
IRON CORES

Recent Stackpole developments include molded Iron Cores for radio equipment operating at frequencies as high as 175 megacycles. Other Stackpole Iron Cores are available in a variety of grades and sizes for frequencies up to 50 megacycles. Molded from metal powders to match your specifications.



POWDER METALLURGY

Stackpole's specialization in molded products has resulted in important progress in the field of molding solids from powdered iron, iron-nickel, and other metal powders. Few recent developments hold such great promise to so many industries as a source of easier-to-obtain, accurate, yet less costly components.



CONTACTS

Stackpole offers suitable contacts for almost every application—from the various silver compositions to dozens of special alloys. Equally important is the Stackpole engineering service that not only helps you select the right contacts, but, if necessary, adapt your equipment to utilize them most efficiently.

Other Stackpole Products
Bearings • Anodes • Electrodes • Battery Carbons • Packing, Piston, and Seal Rings • Brake Lining, etc., etc.

Electronic Components
Fixed and Variable Resistors • Iron Cores • Line Switches, etc.

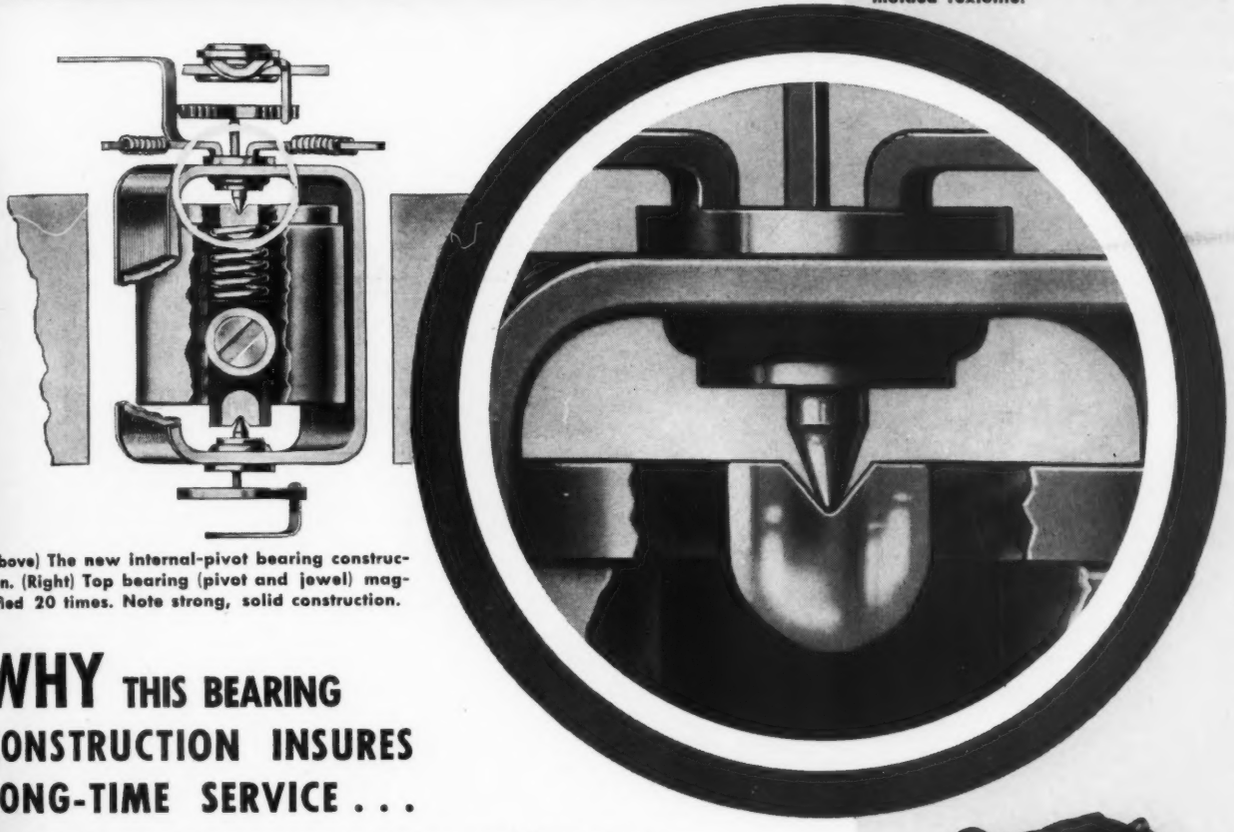
STACKPOLE

STACKPOLE CARBON COMPANY, St. Marys, Pa.

New INTERNAL-PIVOT ELECTRIC INSTRUMENTS

2½-inch - - - 1 inch deep

For radio and other communications service; d-c voltmeters, ammeters, milliammeters, microammeters, and radio-frequency ammeters and milliammeters (a-c thermocouple type). Cases are brass or molded Textolite.



(Above) The new internal-pivot bearing construction. (Right) Top bearing (pivot and jewel) magnified 20 times. Note strong, solid construction.

WHY THIS BEARING CONSTRUCTION INSURES LONG-TIME SERVICE . . .

IN THESE new G-E instruments, the pivots are solidly mounted on the *inside* of the armature shell instead of being cemented to the outside of the armature winding. The result is a rigid construction that helps to maintain accurate alignment.

The steel pivots, highly polished, are of the aircraft type, larger than normal. This means less stress on the bearing surfaces and a construction that will stand rough treatment and shock.

The pivots rotate in low-friction, highly polished, glass vee jewels—one mounted rigidly in the top of the frame-and-core assembly, and the other mounted in a movable lower jewel sleeve located in the soft-iron core.

This combination—accurately formed, hard-glass jewels and large-radius steel pivots—provides a co-ordinated bearing that has proved, by field tests, to be excellent from the standpoint of long life and ability to withstand vibration.

Thin, Strong, Accurate Instruments

1. *Thinness* is obtained by solidly mounting the pivots on the inside of the armature shell. Most instruments are approximately one inch deep.
2. *Strength* is obtained by short, solidly mounted, large-radius pivots and the extra-strong over-all case.
3. *Sustained Accuracy* is insured by the featherweight moving element, combined with high torque and permanent alignment of all parts.

For ratings, prices, and dimensions, ask our nearest office for Bulletin GEA-4064, which covers instruments for use in radio and communications equipment; or Bulletin GEA-4117, which describes those suitable for naval aircraft. *General Electric Co., Schenectady, N. Y.*

D-c voltmeters, volt-ammeters and ammeters are specially designed to measure voltage and current in battery and battery-charging circuits on naval aircraft. They meet applicable Navy specifications.

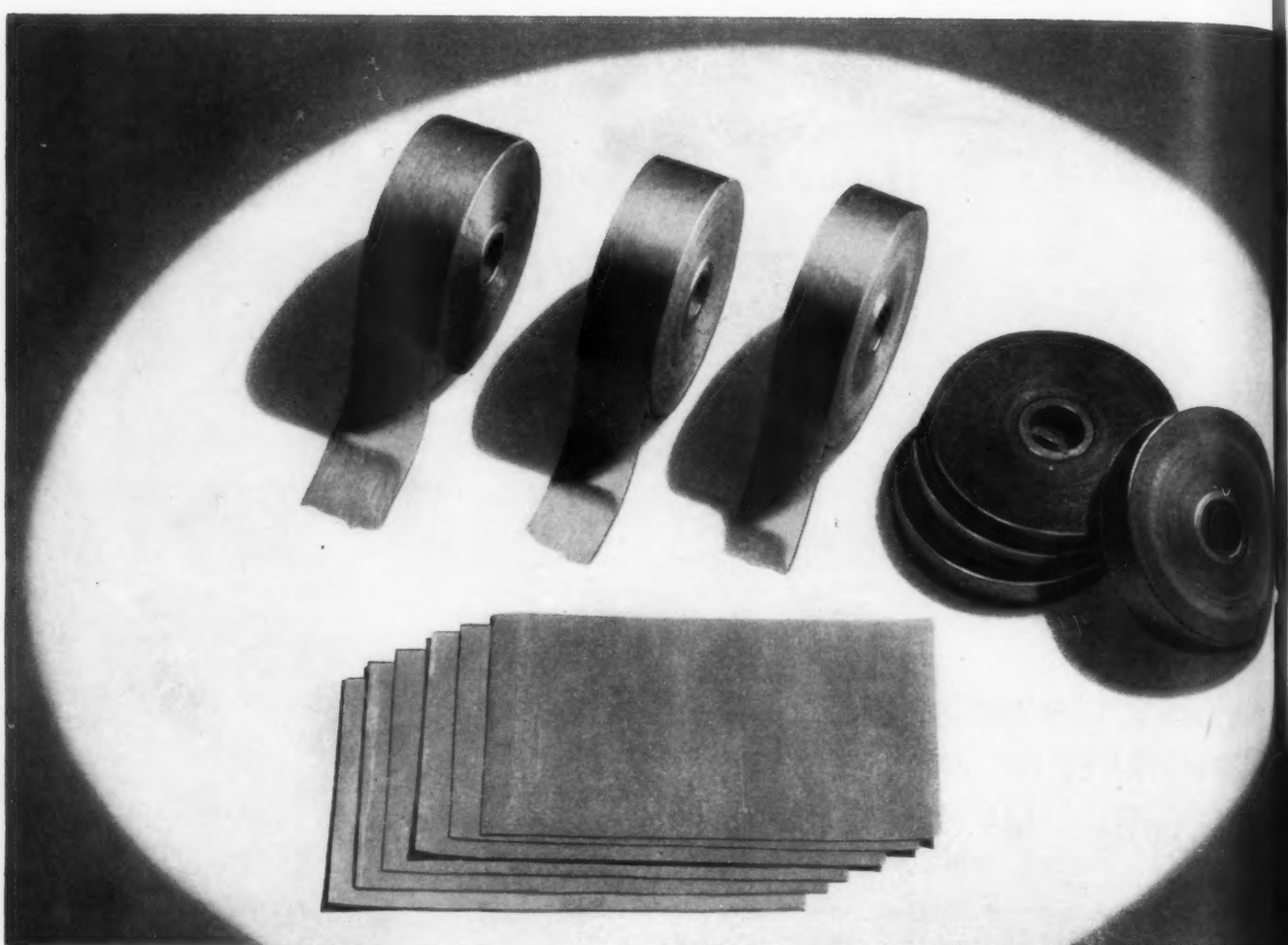
SMALL PANEL INSTRUMENTS

GENERAL ELECTRIC

802-44-6200

Announcing

A NEW Dielectric Material for Capacitors--



LECTROFILM—a new product developed by the General Electric Laboratories—is a synthetic dielectric made from raw materials that are available in large quantities in the United States.

Capacitor manufacturers will find it ideal for use in most radio-frequency-blocking and by-pass, fixed capacitors that for years have been built with mica. These capacitors are of the type used in communications and other electronic equipment.

Lectrofilm has a greater combination of desirable mechanical and electrical properties than any other one capacitor dielectric material. It is available in both rolls and sheets, and can be used in present capacitor production lines, little or no change being required in equipm or manufacturing methods. Its strength a flexibility make it well suited to handling automatic means.

Best of all, lectrofilm has uniform charact istics; it requires little if any grading, sorti or inspection. Therefore, it is economical well as easy to use, and when properly appli will cut down the number of finished capacito that are rejected in test. Users of lectrofi can expect increased capacitor producti with present facilities without any increase man-hours.

Lectrofilm is available for use by manufacture making capacitors for the armed forces.

LECTROFILM

TYPICAL CHARACTERISTICS

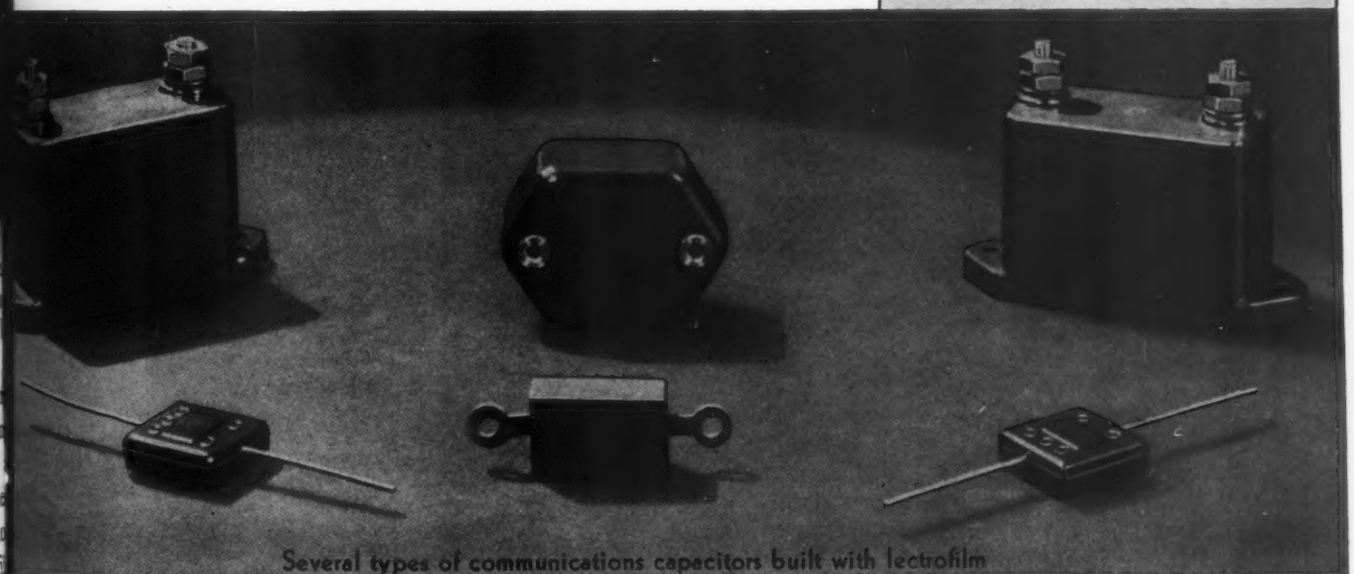
	Lectrofilm in Rolls, No. 2681	Lectrofilm in Sheets, No. 2682
D-c breakdown strength	1900 volts per mil (Two or more thicknesses)	2500 volts per mil
Dielectric constant	4.0 or more	5.5 or more
Tensile strength	Equal to Kraft capacitor paper	Equal to Kraft capacitor paper
Power factor at 1,000,000 cycles* Per cent at 25 C Per cent at 100 C	3.5 or less 1.75 or less	2 or less 1 or less
Capacitance temperature coefficient, per cent per degree C*	0.05 to 0.15	0.05 to 0.15
Maximum recommended operating temperature	100 C	125 C

**These characteristics, determined by actual test results on capacitors built with lectrofilm, will depend on the type of capacitor construction.*

For information on

- **sizes**
- **thicknesses**
- **weights**
- **additional characteristics**

...write for Bulletin GEP-217A. Address: Section 16-216, General Electric Company, Pittsfield, Mass.



Several types of communications capacitors built with lectrofilm

Every week 192,000 G-E employees purchase more than a million dollars' worth of War Bonds

GENERAL ELECTRIC

407-69-57DH

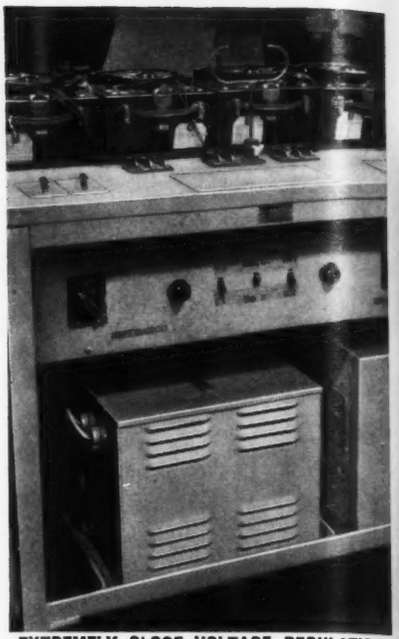
These are the BENEFITS of a CLOSELY HELD VOLTAGE SUPPLY

Better performance, greater reliability, and longer life of electronic devices

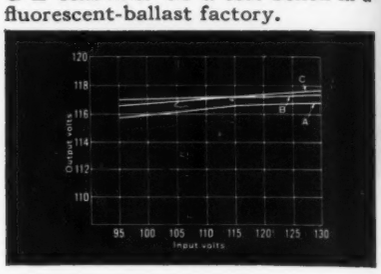
Protection of delicate instruments and machines, precision tools, and electronic tubes against sudden overvoltages

More accurate test results, fewer rejects

And manufacturers—don't forget:
A product's salability can be increased when voltage stabilization is a built-in feature.



EXTREMELY CLOSE VOLTAGE REGULATION, so essential to speedy, accurate production-line testing, is automatically maintained by a 500-volt-ampere G-E stabilizer on a test bench in a fluorescent-ballast factory.



▲ **LOOK AT THIS PERFORMANCE**—Practically constant voltage for several typical conditions (A—Open circuit; B—Full load, unity power factor; C—Full load, 0.8 power factor lagging). Stabilizing action practically instantaneous, taking place in less than three cycles.

...and Here's the Way to Get It

IMPROVES THE PERFORMANCE OF EQUIPMENT LIKE THIS:

Radio transmitters and testing equipment
Photoelectric equipment and other electronic-tube apparatus
Motion-picture projectors and sound equipment
Telephone apparatus
X-ray machines
Precision photographic equipment and photometers
Color comparators
Calibration of meters, instruments, relays
Laboratory precision processes and testing equipment

FOR DETAILS on this stabilizer's unique circuit, write for Bulletin GEA-3634. *General Electric Company, Schenectady, N. Y.*

VOLTAGE STABILIZERS

GENERAL ELECTRIC

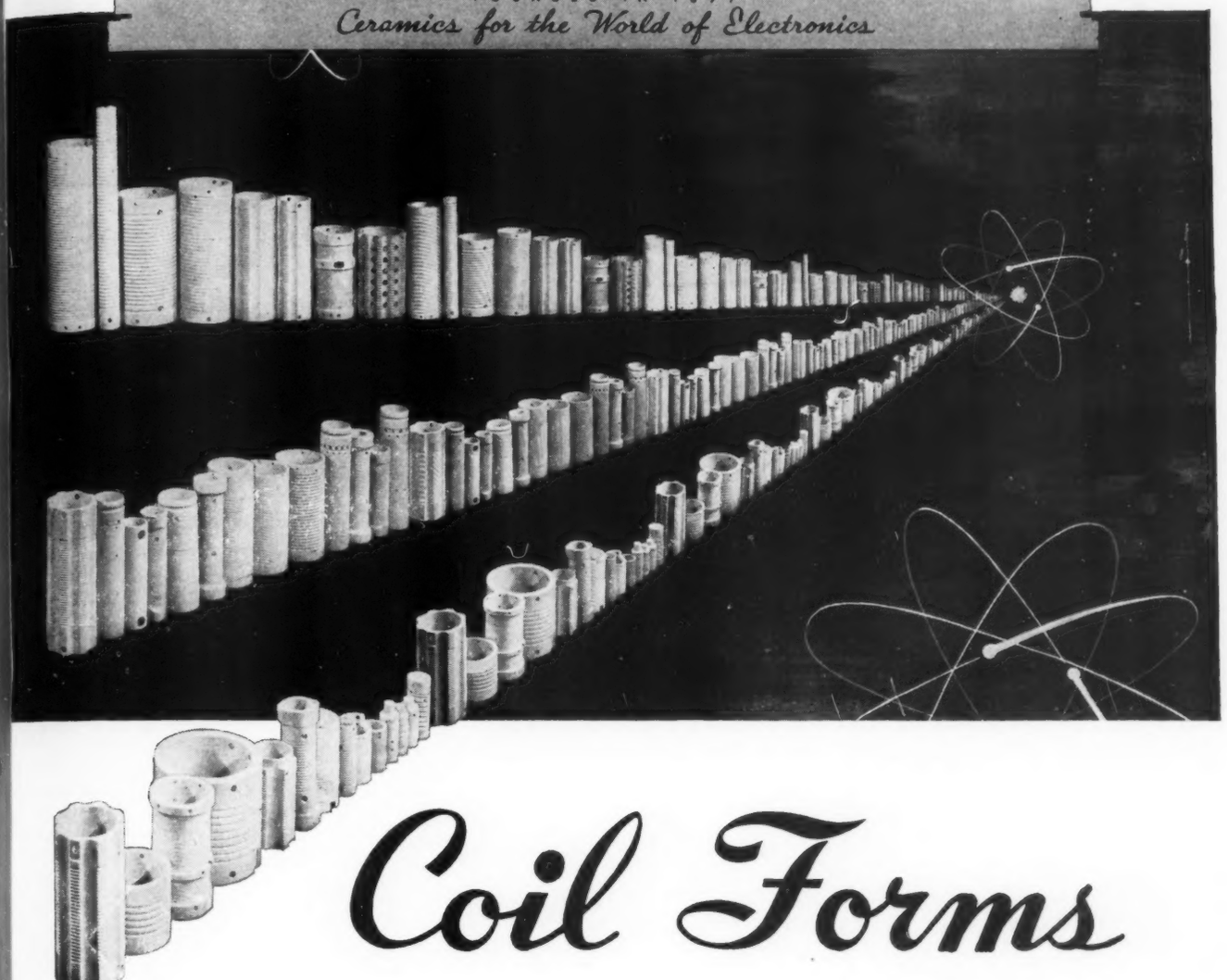
403-53-5205

The best investment in the world is in this country's future—BUY WAR BONDS

STUPAKOFF

FOUNDED IN 1897

Ceramics for the World of Electronics



Coil Forms

PRECISION MADE . . . of Steatite and other materials—glazed or unglazed—any size or shape—to your exacting specifications.

Years of experience—wide technical and engineering knowledge—modern manufacturing facilities enable STUPAKOFF to produce every type of ceramic for the electronic industry.

ARMY E NAVY

"for great achievement"

Back The Attack—With War Bonds

STUPAKOFF CERAMIC AND MANUFACTURING CO., LATROBE, PA.

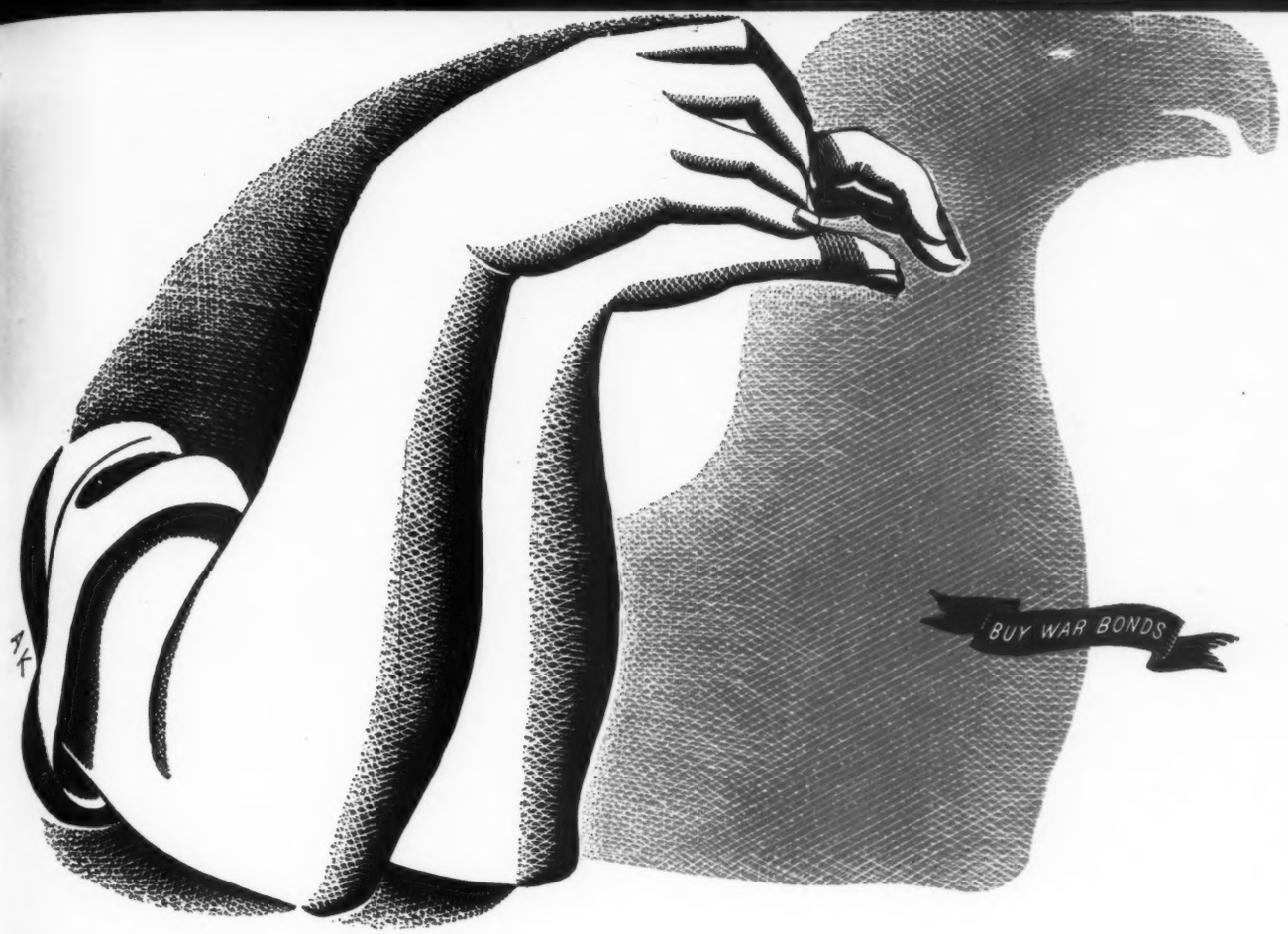
Dependable Power for Blower Applications

. . . Oster Type C-2B Motor (1/100 H. P.) stands up in severe ambient temperatures

This specialized motor, developed for vitally important war-time applications, operates satisfactorily in a 90° ambient, for continuous duty. It is quality-built by the Oster organization, which for 15 years has been building fractional horsepower motors for use exclusively as original equipment on Oster motor-driven appliances. Ball-bearing equipped; built in an aluminum die-cast housing; 6, 12, 24, or 115 volts DC, 115 volts AC . . . You can depend on Oster motors to live up to the world-wide reputation of pre-war Oster appliances, and to deliver results that add to your own reputation for selecting sources wisely. Let us help you fit this or other Oster motors to your requirements. M-13

John Oster Mfg. Co.

Department P-13 **Racine, Wisconsin**



What happens when a Shadow meets an RCA Electron Tube

JUST by itself, it's hard enough to measure to an accuracy of 1/10,000 of an inch. But on a production line, where tens of thousands of wires have to measure up to this accuracy, it's next to impossible—unless you want to spend more time measuring than producing.

However, with a simple electronic device, built around an RCA Electron Tube, thousands of small lead wires for radio tubes are now being checked for such accuracy at the rate of 5 to 8 a minute!

How is it done? Like this . . .

The wire passes before a light. As it does, it casts an enlarged shadow on a sensitive phototube whose output is measured on a meter. If the wire is 1/10,000 of an inch off, the difference is recorded on the meter and the offending wire can be rejected. If desired, the wire can be rotated to measure out-of-roundness.

This is electronics—the so-called "dream science of tomorrow"—in action *today* at RCA. While the device described here is not for sale by RCA, engineers at RCA will be glad to recommend electron tubes around which *your* engineers can design equipment to do any number of jobs better, faster or more economically through electronics.

Remember—the magic brain of all electronic equipment is a Tube . . . and RCA is the fountain-head of modern tube development. For a fascinating booklet entitled "Electrons in Action at RCA," write Room 428, RCA Victor Division, RADIO CORPORATION OF AMERICA, Camden, N. J.

TUNE IN "WHAT'S NEW?"

RCA's great new show, Saturday nights, 7 to 8, Eastern War Time, Blue Network.

This machine, while used at RCA to measure the diameter of tungsten wires by an electronic method, embodies a basic principle for measuring any critical dimension of any component that can be made to cast a shadow directly proportional to the dimension to be checked.

ASK ABOUT... RCA INDUSTRIAL MUSIC SERVICE

RADIO CORPORATION OF AMERICA

ADLAKE *Plunger-type* MERCURY RELAYS

Snap Action

That Stays "Snappy"!

Adlake Model 1040
For panel mounting. This relay can be supplied with either quick or time delay action; normally open or closed; and for a.c. or d.c. energization. Contact ratings up to 100 amperes a.c. with proportional d.c. ratings.

MERCURY moves *fast.* You know that because you've seen it in action. Due to this inherent characteristic of mercury, Adlake plunger-type *mercury* relays provide the *snap action* so desirable in a relay when contact is made—or broken.

There is positively no tendency toward "molasses in January" operation in these relays. Their action is "snappy" and it *stays "snappy"!*

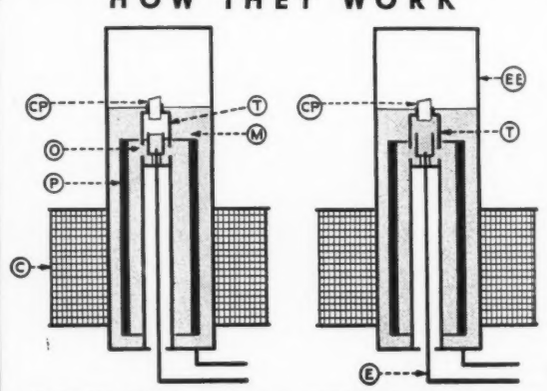
Hermetically Sealed Contact Mechanism

Contact mechanism of Adlake plunger-type mercury relays is hermetically sealed in an *armored* glass or metal cylinder. Dirt, dust, moisture, or oxidation cannot interfere with operation—*in any way or at any time.*

The *liquid* metal mercury contact is positive in action, chatterless, silent, and impervious to burning, pitting, and sticking.

For many kinds of service, no other type of relay provides equal *stamina* and *dependability.* Request complete bulletin.

HOW THEY WORK



ENERGIZED—*Coil C pulls plunger P down into mercury. Mercury thus displaced enters thimble T through orifice O. Inert gas in thimble gradually escapes through ceramic plug CP—thus producing time delay.*

ENERGIZED—*Mercury now fills thimble T, is completely leveled off and mercury-to-mercury contact established between electrodes E and EE. Degree of porosity of ceramic plug CP determines length of time delay.*

Adlake TRADE MARK

THE ADAMS & WESTLAKE COMPANY

ESTABLISHED IN 1857 — ELKHART, INDIANA — NEW YORK · CHICAGO

MANUFACTURERS OF ADLAKE SPECIALTIES AND EQUIPMENT FOR RAILWAY, AIRWAY, HIGHWAY, AND WATERWAY

Pre-War Model

EXCERPTS :

Dear Bill:

The answer is " YES ". Record Changers have top billing in our Post-war plans. After all, what

realistic about it. You're right again. There will be an unprecedented demand for Record Changers in Post war home phonographs. And we will have the capacity to handle it. Glad you remember our Pre-war Changer did make a hit back in '40 and '41.

Dear Russ:

Your letter bothers me because you have known us for years and must know that we don't talk until we are ready. We'll be happy to talk Post War Record Changers with you but don't ask us to show our hand right now... Don't worry... the new one will be a honey... our enthusiasm is unbounded and we won't be late. Please be patient. You will find

in the period immediately following the end of the war. What do you mean... WE are hoarding ideas ? We have asked you for your ideas and you know it takes time to adapt them.

you've got to hand it to the radio manufacturers. They know a good thing when they see it. And they don't forget. Like yourself they know about G.I.'s pre-war record changer.

Just wait til you see our new one. If your enthusiasm doesn't match ours I'll eat your hat. Sorry we can't unwrap the package for you right now. We've got to get on with the war. Army and Navy contracts

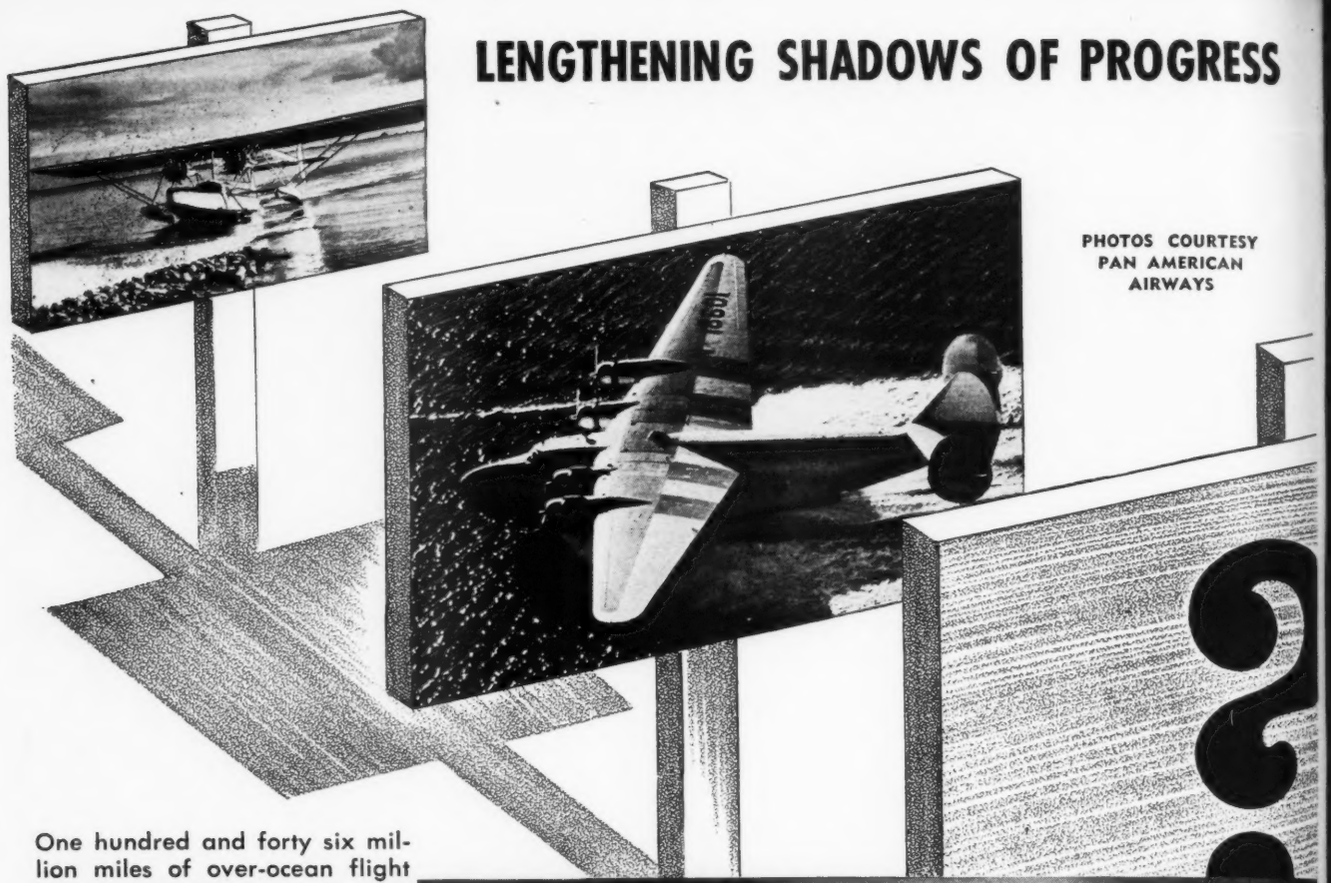
WAR BONDS—An Investment in Your Country's Future

General Instrument CORPORATION

ARMY E NAVY

EXECUTIVE OFFICES • 829 NEWARK AVENUE • ELIZABETH 3, N. J.

LENGTHENING SHADOWS OF PROGRESS

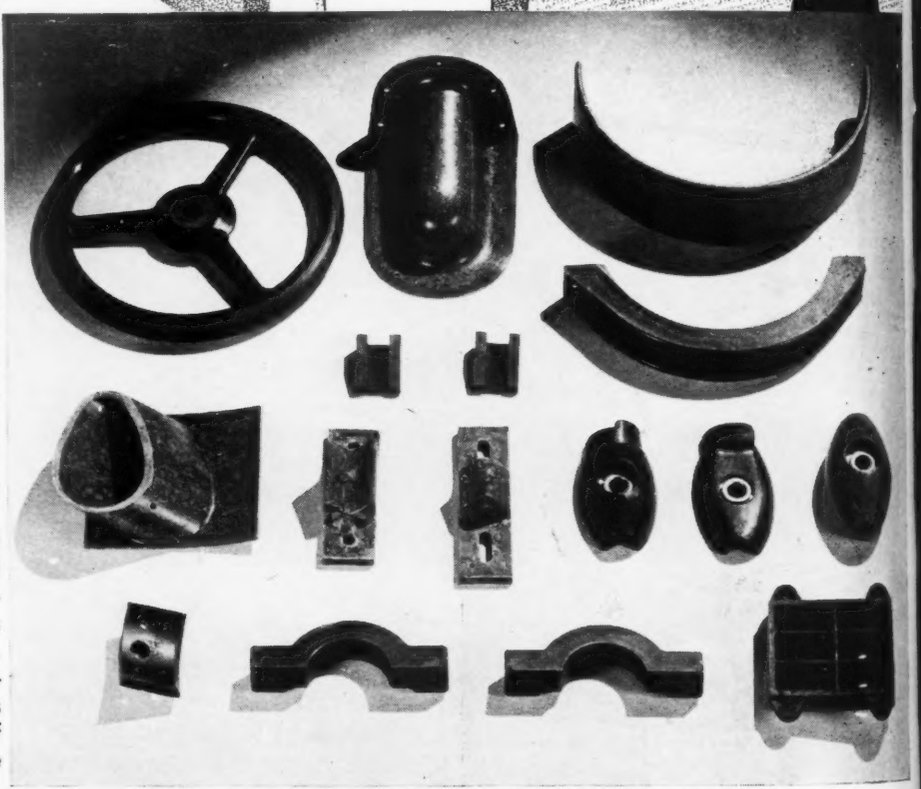


PHOTOS COURTESY PAN AMERICAN AIRWAYS

One hundred and forty six million miles of over-ocean flight have been built up over the past years by Pan American Airways. This enviable record is but the ever-lengthening shadow of progress—a shadow that was first cast in 1927 by Pan American's first marine air transport, the Sikorsky S-30.

In this march of progress C-D plastics likewise are casting ever-lengthening shadows of progress, because of the sound, scientific development on C-D's part that has resulted in producing better-functioning aviation parts that are a great help in making today's huge "flying boats" possible.

C-D Plastics DILECTO laminated phenolics; CELORON molded phenolics; DILECTENE low loss insulation, are all filling vital roles in electrical insulating parts, structural parts and where lightweight, non-corrosive properties and stability under extremes of moisture and temperature are essential.

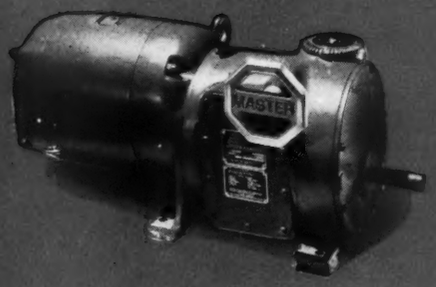


C-D products include THE PLASTICS . . . DILECTO—a laminated phenolic: CELORON—a molded phenolic: DILECTENE—a pure resin plastic especially suited to U-H-F insulation . . THE NON-METALLICS, DIAMOND Vulcanized Fibre: VULCOID—resin impregnated vulcanized fibre: and MICABOND—built-up mica insulation. Folder GF describes all these products and gives standard sizes and specifications.

DISTRICT OFFICES: New York - Cleveland
Chicago - Spartanburg, S. C.
West Coast Rep., Marwood, Ltd., San Francisco
Sales Offices in principal cities

Continental-Diamond FIBRE COMPANY

Established 1895 . . Manufacturers of Laminated Plastics since 1911 — NEWARK • DELAWARE



Are you enjoying the advantages of

VARIABLE SPEED

On many applications, variable speed operation offers tremendous advantages. The Master Speedranger provides this infinitely variable speed in a compact all metal unit of proven reliability.

SIMPLE COMPACT DESIGN Only with an all-metal drive is it possible to secure the compactness, simplicity, flexibility and economy that are so advantageous on modern production machines and processes.

ALL-METAL The all-metal construction insures long life and the greatest possible freedom from interruptions to service. The design is extremely simple, consisting of a metal ring which operates at a variable position on the two driving and two driven cones. The position of the ring on the cones determines the speed of the output shaft.

PROVEN RELIABILITY Millions of hours of service in the field and exhaustive tests in the laboratory have proven conclusively the complete reliability of this device.

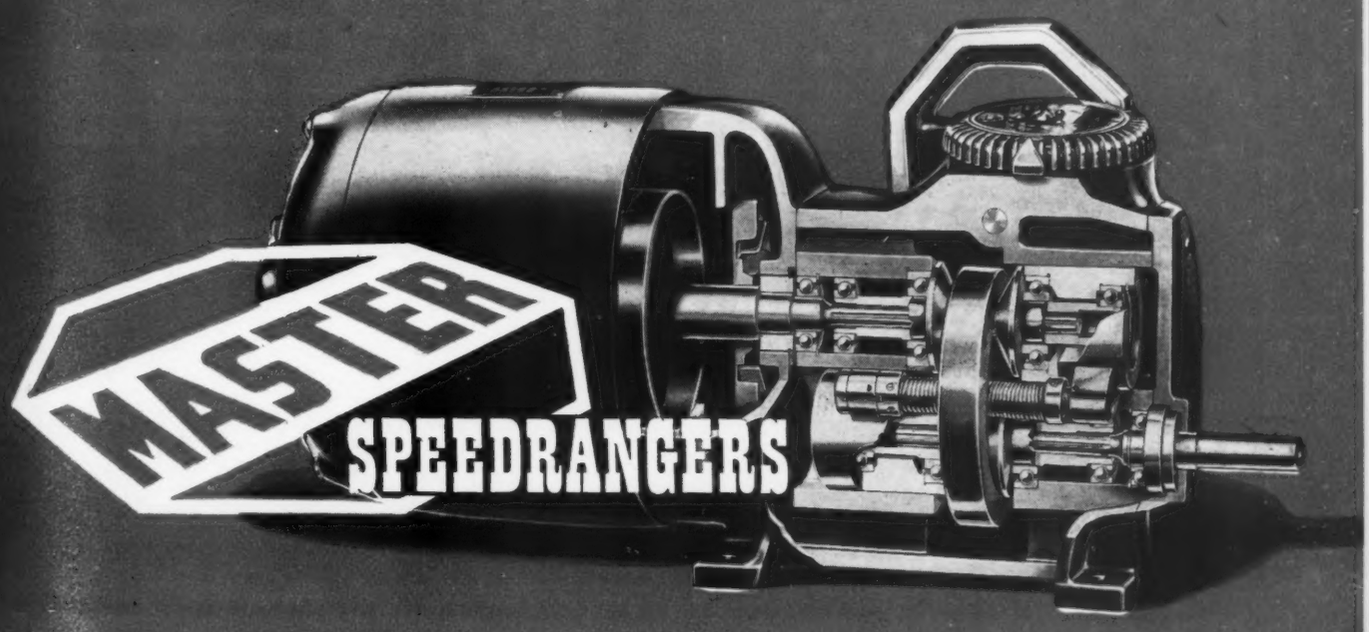
EXTREME FLEXIBILITY Speedrangers can be supplied for single phase, polyphase, or direct current operation. They can be furnished also with integrally built gear reduction units and electric brakes . . . in enclosed, splash proof, fan cooled or explosion proof construction and for a wide variety of mounting arrangements. No other variable speed unit on the market today can give you such flexibility and compactness.

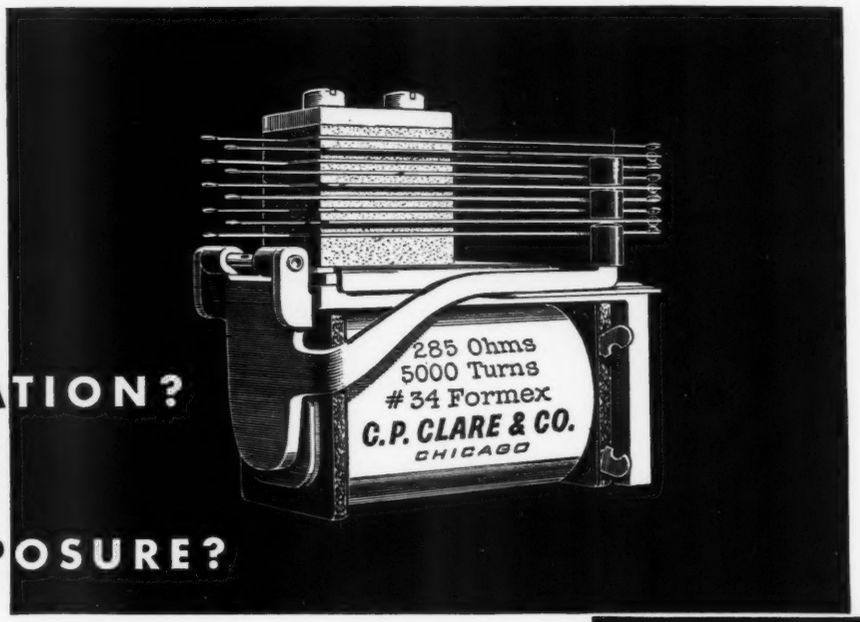
UNDIVIDED RESPONSIBILITY The complete Speedranger is designed and built in one plant by one manufacturer as an integral, compact power unit.

HORSEPOWER Now available in sizes up to and including 3 horsepower.

SPEED RANGES Up to 9 to 1 are available. (up to 15 to 1 in some sizes).

THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO





VIBRATION?

SHOCK?

EXPOSURE?

This CLARE Type G Relay Withstands Them All!

THIS Clare Type G Relay has come through the rigorous tests of war with flying colors. Its ability to withstand unusual shock, vibration and exposure has been proven time and time again in aircraft use, in radio equipment, compasses and controls of all kinds.

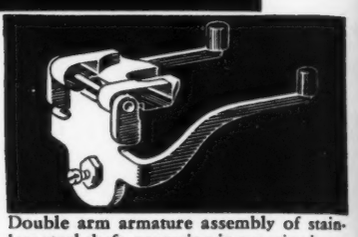
Clare Type G is a short coil relay—just 2½" x 2¼" x 1¼" and weighs but 6½ ounces. Coils are carefully wound to exact turns on precision machines. They are protected with a transparent acetate covering and are available impregnated with special varnish. The pile-up shown is of nine springs, but as many as twelve springs can be used.

Permanency of the spring tension is assured by the way in which the spring pile-up is assembled. Heelpiece and pile-up are placed in a hydraulic press while automatic screw drivers tighten the high tensile screws which hold the pile-up to the heelpiece.

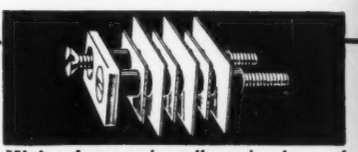
Contacts of rare metals or special alloys can be used either flat or hemispherical and in sizes from .062" to .1875" diameter. The core, heelpiece and armature are made from the highest quality magnetic iron. This is purchased to rigid specifications and carefully annealed in precision controlled furnaces in our own factory.

Type G like all Clare "custom built" relays can be accurately adapted to the specific requirements of your design. We will be glad to work with you to that end. Let us know what your relay problem is. Our engineers will be glad to put our years of relay experience at your service.

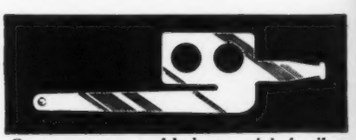
Send for the Clare catalog and data book. C. P. Clare & Company, 4719 West Sunnyside Ave., Chicago (30), Ill. Sales engineers in all principal cities. Cable address: CLARELAY.



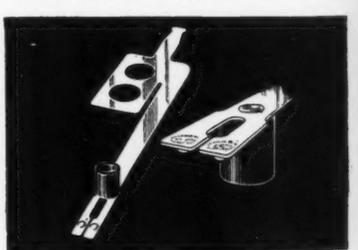
Double arm armature assembly of stainless steel shaft, operating in a marine brass yoke. Heelpiece, core and armature assembly of magnetic metal.



High voltage spring pile-up insulators of special heat treated Bakelite. Has minimum cold flow properties, low moisture absorption content; and permits punching without cracks or checks.



Contacts are welded to nickel silver springs by special process. May be of precious metals or alloys in 12 different standard, or special, types and sizes.



Spring bushing insulators are made of Bakelite rod under patented process. Resist vibration and withstand heavy duty service.

CLARE RELAYS

"Custom-Built" Multiple Contact Relays for Electrical, Electronic and Industrial Use

STALWART, WAR-TIME POWER

American-made motors and generators have met the two and three shift requirements of war industry, with an astounding record of trouble-free performance.

A sizeable proportion of these bear the Crocker-Wheeler name . . . quite a few of them are *older* than the operators of the machines they serve. For Crocker-Wheeler motors and generators, for over 50 years, have been carefully and durably built.

CROCKER WHEELER ELECTRIC MANUFACTURING CO.
Ampere, N. J. • *Division of* JOSHUA HENDY IRON WORKS

For engineering and service information, call . . .

*Boston	(COM 6907)	*Detroit	(TR 2-5785)
*Buffalo	(CL 4985)	New York	(CO 7-6700)
*Chicago	(FRA 1616)	Philadelphia	(WAL 1444)
Cincinnati	(MA 1345)	Pittsburgh	(AT 9818)
*Cleveland	(MA 3255)	*San Francisco	(EX 5531)
	Washington (EX 1991)		

. . . or your local Crocker Wheeler dealer ** Local Stock*

Be SURE . . . with CROCKER WHEELER

Other JOSHUA HENDY IRON WORKS factories at Sunnyvale, Pomona, Torrance, and Long Beach, California, and St. Louis, Mo.

See an Ozalid machine in operation

The chances are—Ozalid whiteprints are being made in a plant in your vicinity ...and you may be able to witness a demonstration of simplified printmaking.

Bring your own engineering drawings. *See* how you can make whiteprints in one continuous operation . . . and save time, labor, and materials.

COMPARE OZALID WITH ANY OTHER METHOD

You'll be surprised at the compactness of an Ozalid machine.

It can be installed in any corner of the drafting room. This saving in floor space is possible because Ozalid eliminates the chemical baths, driers, and plumbing connections employed in other processes.

This simplification allows you to quickly train an inexperienced person to operate the machine at top efficiency.

In addition, you get exclusive printmaking extras! . . .

CHECK THESE OZALID EXTRAS

1. You're able to use the widest variety of sensitized materials—papers, cloths, and foils . . . and make prints having blue, black, or maroon lines on a white background.

You'll find that Ozalid whiteprints are easier to read and check than blueprints. They are also fade-proof and wash-fast.

2. You make "duplicate originals" in the same manner as standard prints —no Van Dyke difficulties. These may be used in place of the original in subsequent print production...or to eliminate unnecessary drafting when making design changes.

It is not necessary to redraw any part which remains the same as in the original!

3. You're able to use cut sheets as well as roll stock in an Ozalid machine, thereby eliminating trimming waste.

No paper is lost by pasting up "leaders."

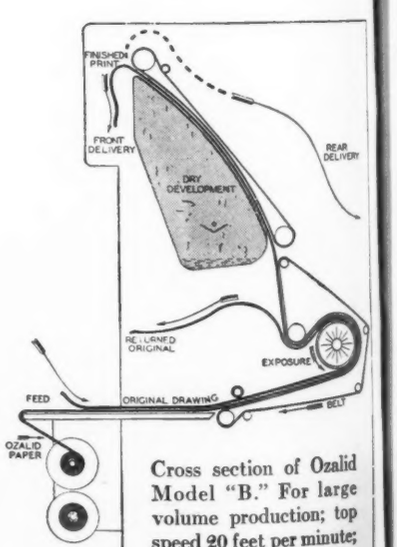
No prints are unusable because of distortion.

FULL LINE OF MACHINES

There's an Ozalid machine for every print production requirement. So if you want to turn out prints at speeds up to 20 feet per minute—or if you need only a dry developing unit to use with your present printer—adopt Ozalid.

Write for catalog and sample booklet of whiteprints. See how leading manufacturers, save time, labor, and materials.

OZALID—MORE THAN A PRINTMAKING PROCESS



Cross section of Ozalid Model "B." For large volume production; top speed 20 feet per minute; front or rear print delivery; many new features.

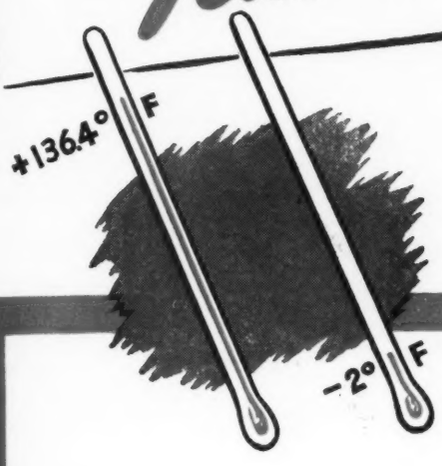
OZALID PRODUCTS DIVISION

GENERAL ANILINE AND FILM CORPORATION

Johnson City, N. Y.

OZALID IN CANADA—HUGHES OWENS CO., LTD., MONTREAL

GIVE YOUR MOTORS THIS OVERLOAD PROTECTION *Today* ...TO ASSURE PRODUCTION *Tomorrow*



Extremes in ambient temperature do not affect the performance of the Thermaload V . . . because overload alone trips the Monitor *Compensated* Overload Relay. In tests at 600% heater rating . . . at the two extreme temperatures shown above . . . the tripping time varied only a few seconds. Your motors may never be subjected to such conditions but remember . . . even *normal* variations in temperature will affect the operation of thermal overload relays unless these relays are compensated. Play safe . . . specify the Monitor Thermaload V Solenoid Starter for original equipment and replacement.

The Monitor THERMALOAD V

SOLENOID STARTER

The Monitor Thermaload V Solenoid Starter will provide the highest degree of overload protection available for your valuable motors. It will give the same full protection in hot, cold or changeable temperatures. It is designed so that careless or over-zealous operators cannot "block in" the reset button to prevent the trip. Shock-proof mounting separates magnet frame from base. Quality construction provides long life. Thoughtful design provides for easily-interchangeable coils for different voltages—quick replacement of double-break silver contacts.

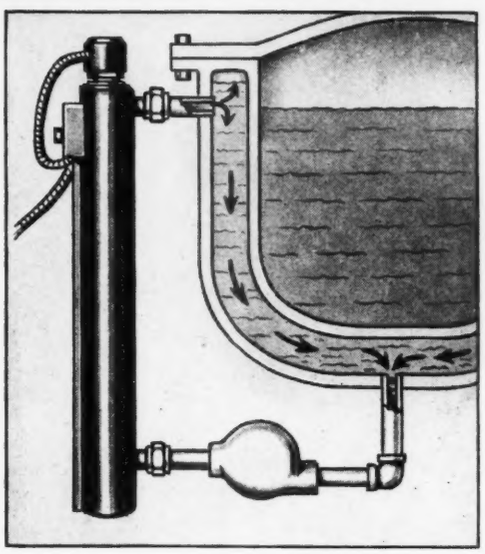
Add these features up . . . consider Monitor's 55 year record of important contributions to precision motor control . . . and it is evident that for 1.5 to 7.5 H.P., 110-550 Volts A.C. Motors . . . the Monitor Thermaload V is your best bet for overload protection.

At present—we can promise PROMPT DELIVERY FROM STOCK. Please comply with existing priority regulations when ordering.

TheMonitorControllerCompany

GAY, LOMBARD & FREDERICK STS. BALTIMORE-2, MARYLAND

How to use ELECTRIC HEAT in oil circulating systems with CHROMALOX ELECTRIC HEATING UNITS



Above, the NWH heater which is a complete unit for the quick and convenient application of electric heat. The unit includes heating element, inner jacket, outer insulating jacket, pipe connections, thermostat and bulb.

•

Ask the Wiegand engineering staff to work with you in using electric heat. Write us, including rough descriptive pencil sketch. For valuable data, ask us for the Chromalox Catalog.

IN OIL JACKETED EQUIPMENT electric heat can be applied simply, easily, quickly, with Chromalox NWH Circulation Heaters.

The unit is complete in itself, designed specifically for the purpose.

Only two pipe connections needed, and connection to electric power line.

Temperature accurately maintained by thermostat, included with the unit. Assures uniform conditions and perfect product.

"Heat by wire" avoids flame hazard, steam piping troubles, bulky installation, operator discomfort. Cost is in line with other methods of heating.

IN PREHEATING FUEL OIL the Chromalox NWH Heater is widely used. May be connected anywhere on the oil supply line. Promotes combustion, and saves fuel cost by permitting the use of lower grade oil.

•

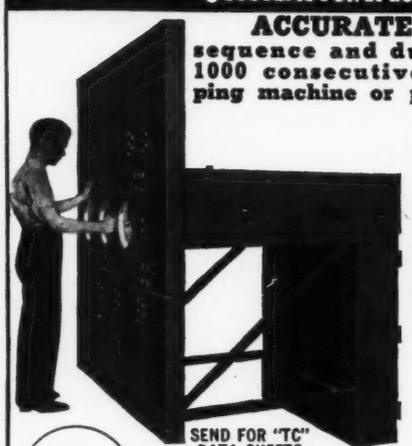
Chromalox NWH Heaters are available in capacities from 1-kw. to 15-kw. Largest size will support oil pressures to 125 lbs. at 450 deg. F. Smaller types will take pressures to 300 lbs. at 500 deg. F. For large capacity, units can be connected in series. Consult with our engineering department as to the unit you need.

EDWIN L. WIEGAND COMPANY
7535 Thomas Blvd., PITTSBURGH 8, PA.

TIMERS

DESIGNED for INDUSTRIAL APPLICATIONS
● COMPLETE STANDARD LINE AVAILABLE
● SYSTEMS FOR SPECIAL REQUIREMENTS

ACCURATELY CONTROL sequence and duration of 1 to 1000 consecutive and overlapping machine or process functions



SYNTHETIC RUBBER PROCESS TIME CONTROL . . . one of largest built! Synchronous motors drive twin shafts, each with 41 cams and mercury switches to control operations. Cam cycle may be adjusted in steps from 6 to 18 min. Color coded flow chart, indicator lights, common terminal board, enclosed cabinet, internal lighting and lock-handle doors are features.

When YOU SHOULD INCLUDE ATC TIMERS IN YOUR MACHINE OR PROCESS DESIGN
Assure Uniform Product
Obtain Maximum Operation
Increase Output
Reduce Rejects
Eliminate Human Errors
Save Man-hours
Conserve Skilled Operators
Cut Production Cost

SEND FOR "TC" DATA SHEETS

atc Industrial Controls
AUTOMATIC TEMPERATURE CONTROL COMPANY, INC.
34 E. LOGAN STREET, PHILA. 44, PA.

"SURCO-AMERICAN" *means* **PRETESTED** *under all conditions*

"Surco-American" high quality flexible plastic tubings and insulated wire are pretested to stand up under a wide range of temperatures and under the most severe conditions because they are specially formulated to meet the most exacting requirements. Tubings are available in inside diameters from .005" to 2". Dielectric strength averages 1500 volts per mil. thickness . . . "Surco-American" flexible plastic insulated wire is available in all lengths and colors in wire sizes #12 to #48 A.W.G. solid or stranded, shielded, tinned or silver plated copper wire and cable . . . Technical bulletins and samples on request.

Surprenant ELECTRICAL INSULATION CO.
Address Dept. B
84 Purchase Street
Boston, Mass.

"ESCO" AT WAR!

All of our motors, generators, motor-generators, converters and generating plants now go to war.

Our greatly increased production has enabled us to enlarge our facilities and improve our products.

We will be in a better position than ever to serve you after the war.

ELECTRIC SPECIALTY CO.
209 SOUTH STREET STAMFORD, CONN.

In the tight spots it's a STAR

AVAILABLE ON REQUEST . . . Handsome full-color 10"x10" reproduction of this great, dramatic painting by an actual eye-witness—Lt. Commander Anton Otto Fischer, the internationally famous marine painter. No advertising matter.

Up came the German sub—the sixth to face the U. S. Coast Guard Cutter *Campbell*, in 18 hours. Seconds later, the U-Boat was reeling under the cutter's withering fire against her steel decks and conning tower, recoiling from the impact of the cutter's starboard side against her pressure hull, floundering helplessly as shell after shell from the *Campbell's* after-guns crashed into her plates. Minutes later, down went the sub for the full count.

Now it was seen that the sub's port hydroplane had ripped through the *Campbell's* hull. Soon the engine room was flooding, the main electrical switchboard swamped. All power failed. The *Campbell* was a drifting, helpless hulk in the night. Could STAR help the *Campbell* through this "tight spot?" Star could — and did. When the main lighting and power systems failed, a Star Auxiliary Generator—installed for just such emergencies—provided light, refrigeration and power for cooking, radio, and other purposes until the *Campbell* reached port.

Thus, in more ways than one, Star proves its worth in the "tight spots." And in the actual "tight spots" of your product, where stamina must be combined with specific space adaptation, you'll find Star's unique welding process ready to fill the bill—without special patterns or special castings.

★ STAR ELECTRIC MOTOR CO., Bloomfield, New Jersey ★

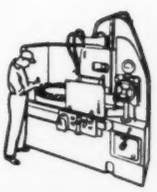
POWER *PACKAGED* AS YOU NEED IT

ARMY E NAVY

STAR MOTORS

PERMANENT MAGNETS

THE Arnold Engineering Company is thoroughly experienced in the production of all **ALNICO** types of permanent magnets including **ALNICO V.** All magnets are completely manufactured in our own plant under close metallurgical, mechanical and magnetic control.



THE ARNOLD ENGINEERING COMPANY

147 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS

HIGH CAPACITY AT LOW COST

V-300

LOW PRESSURE GAS REGULATORS

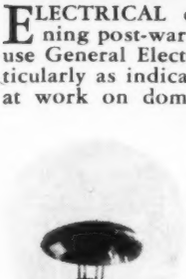
GENERAL CONTROLS V-300 gives continuous, efficient operation at low cost. This compact low pressure gas regulator is built to last... Available in correct materials for handling natural, manufactured and L. P. gases... the V-300 is furnished in sizes ranging from ⅜" to 2" I.P.S... Standard outlet pressures range from 2" to 5"; factory setting 3½" for average appliance use. Write for Catalog No. 52 with complete specifications.

GENERAL CONTROLS
801 ALLEN AVENUE • GLENDALE 1, CALIFORNIA
Branches: Boston • New York • Philadelphia • Cleveland • Detroit
Chicago • Dallas • Denver • San Francisco

G-E NEON GLOW LAMPS for Post-war Product Designs

ELECTRICAL equipment manufacturers planning post-war products will find many ways to use General Electric Neon Glow Lamps . . . particularly as indicators or pilots. Design engineers at work on domestic and commercial electrical devices are already specifying these lamps because of such unique properties as:

1 *Remarkable resistance to shock or mechanical abuse.*
2 *Very low current consumption with low operating temperatures.*
3 *Characteristic and distinctive red color.*
4 *Applicability to commercial voltages including higher ranges. (By use of simple small series resistor.)*
5 *Unique electrical characteristics for special circuits such as self flashing on direct current.*



TYPE S-14 G-E Neon Glow Lamps in 3 and 2-watt sizes start at approximately 60 volts AC, 85 volts DC.

See your electrical wholesaler. For a useful folder showing many uses, write Department PE - 12, at the address below.

NELA SPECIALTY DIVISION, LAMP DEPT.
GENERAL ELECTRIC
410 Eighth Street, Hoboken, N. J.

☆ ☆ WAGNER PRODUCTS SPEED VICTORY ☆ ☆

Wagner

CHEMICAL-PROOF MOTORS

These motors are especially designed to resist the damaging action of acids, fumes, moisture, and other destructive elements. They are ideal for chemical manufacturing plants, as well as in industrial plants where operating conditions are adverse to the use of open-type motors.

Features of Construction

Wagner Type CP Chemical Motors have windings which are well insulated and impregnated, and coils and free-ends of stator windings are shaped to fit snugly into special slot cells.

After windings are in place, the stator is baked to remove all moisture, and while still hot it is immersed in a heavy insulating varnish. When this coating is completely dried, the stator is then given another dipping and baking to insure complete impregnation. Finally, it is treated with a heavy coat of a special alkali- and acid-resisting varnish, which produces a tough oil-proof coating.

The conduit box is moisture-proof and dust-tight, and is screwed onto a nipple solidly welded into the side of the motor. The cover of the conduit box is firmly held by four bolts.

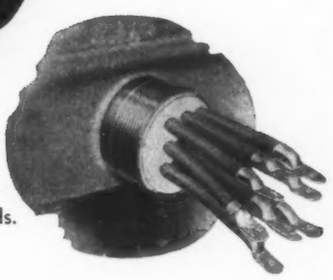
All lead openings are completely sealed with a flexible compound, preventing the entrance of dust, fumes, moisture and other harmful elements.

Special drain plugs in the bottom of the endplates and conduit box provide for the removal of any condensation from the motor or conduit box.

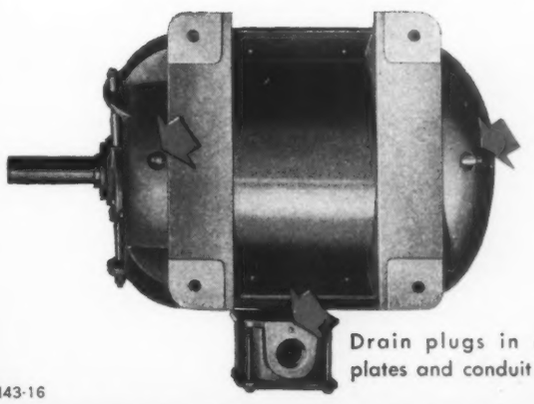
The inner frame completely seals the windings and bearings while the outer frame guides a cooling draft over the motor.

Other features include: dynamic balance (running balance) which insures freedom from vibration; and completely sealed ball bearings.

Conduit box—screw-on type.



Completely sealed leads.



Drain plugs in endplates and conduit box.

M43-16

Write for complete information!

Wagner Electric Corporation

ESTABLISHED 1891

6406 Plymouth Avenue, St. Louis 14, Mo., U. S. A.

ELECTRICAL AND AUTOMOTIVE PRODUCTS

IT'S THE *Rolling Spring*

that assures better contacts and higher operating speeds

Acro Snap SWITCHES

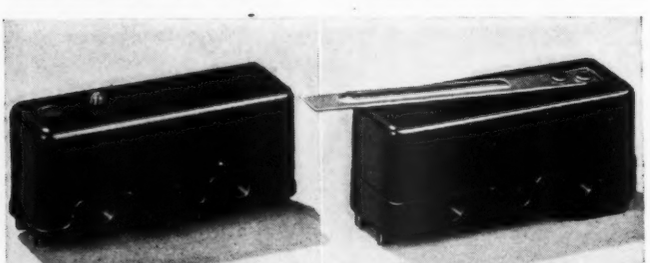
• Better contact and higher operating speed is assured with the patented rolling spring ACRO SNAP SWITCH. When we say BETTER CONTACT we definitely mean BETTER CONTACT with the same operating pressure. This minimizes contact burning and greatly lengthens switch life. Many types of ACRO SNAP-ACTION SWITCHES are used in aircraft and other vital war equipment where unfailing performance is essential. If you have not yet handled and studied the ACRO rolling spring SNAP-ACTION SWITCH an experience is awaiting you.

For fast action on samples, kindly explain nature of application you contemplate.

• • •

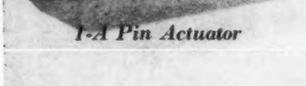
ACRO ELECTRIC COMPANY

1310 SUPERIOR AVE., CLEVELAND, 14, OHIO

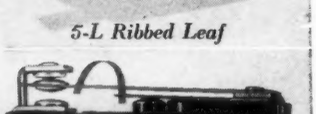


1-A Pin Actuator

5-L Ribbed Leaf

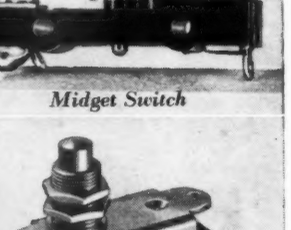


Open Blade Switch

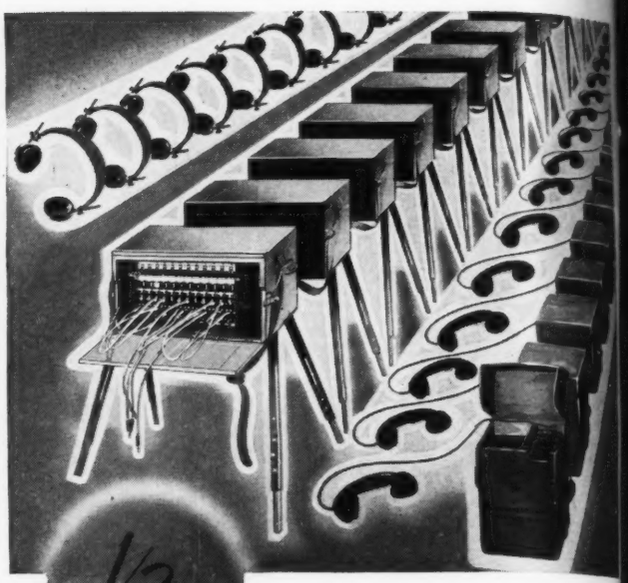


Midget Switch

1-O Overtravel Plunger



Bracket Switch



1/3 more NEEDED TODAY

... than in September

WITH Allied armies on the march and the retreating Axis forces destroying all existing facilities, the need for telephone communications systems is soaring.

The record of the telephone equipment manufacturing industry in this war should be a sufficient guarantee that our fighting men will continue to get what they need, regardless of the enormity of the job.

The men and women at "Connecticut" have made a record that stands out even in an industry famous for its wartime accomplishments.

We submit the record we are compiling now, as evidence of ability to serve postwar America. We are glad to consult with manufacturers seeking help on electronic or electrical product developments — also with engineers who have developed ideas that might round out our postwar plans.

CONNECTICUT TELEPHONE & ELECTRIC DIVISION

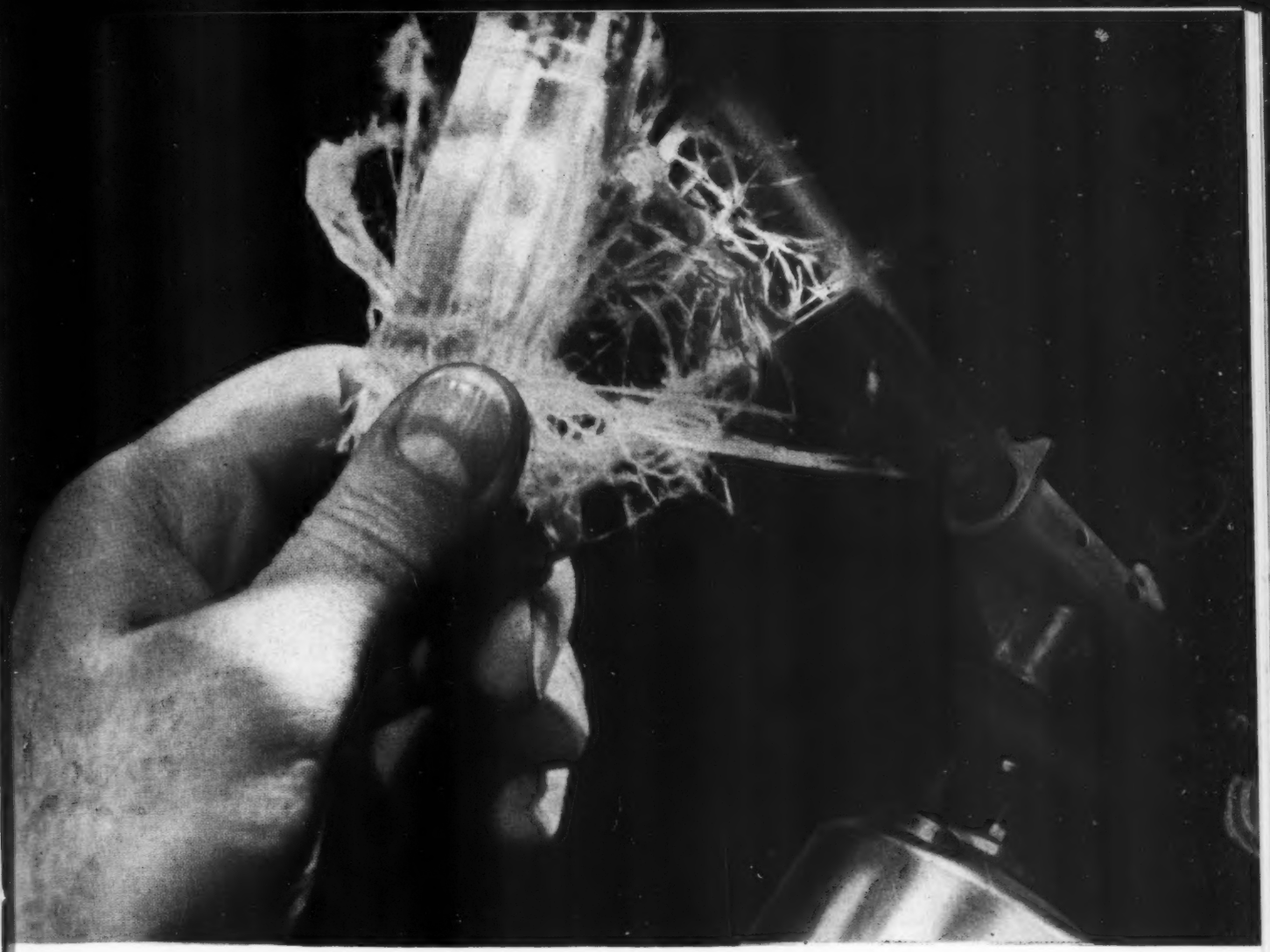
GAI GREAT AMERICAN INDUSTRIES

MERIDEN, CONNECTICUT

ARMY E NAVY

Engineering, Development, Precision Electrical Manufacturing

© 1943 GAI, Inc., Meriden, Conn.



ASBESTOS CANNOT CARBONIZE

...USED EXCLUSIVELY IN U. S. MOTORS

ASBESTOS is a fibrous rock that has not changed in character for ages. It is the only known natural fibre that is absolutely incombustible. Asbestos is the protecting element in U. S. Motor windings.

Life of a motor is proportional to the life of the insulation protecting the windings. If carbonization starts to progress, the insulation chemically and physically changes from an insulator to a conductor. Thus, destruction of the windings is threatened from failure of the very thing that was originally designed to protect them.

Materials commonly used for insulation include varnished cloth, oiled linen, paper, press-board, insulating varnish; but *all of these will carbonize.* Not one of them is fireproof. All of these, even the best, will deteriorate under the temperatures at which motors are often called to operate. Repair shops, busy rewinding motors, furnish proof of the continuous carbonization of motor windings.

Contrast such construction with the advanced U. S. Motor method of using Asbestos as the protecting element. While there is no way of protecting motors to guarantee perpetual life, the U. S. Asbestic Process of insulating windings infinitely increases motor life. Danger of breakdown is minimized.

Asbestos is the greatest of all pliable, heat-resisting materials *because it cannot carbonize.* (That's why asbestos is used in automobile brakes.) Being soft and flexible it is an insulation that can be folded and worked into the windings of U. S. Motors. Asbestos is a high heat conductor. It transmits heat away from the inside of the motor much faster than ordinary elements.

U.S. MOTORS
ASBESTOS-PROTECTED

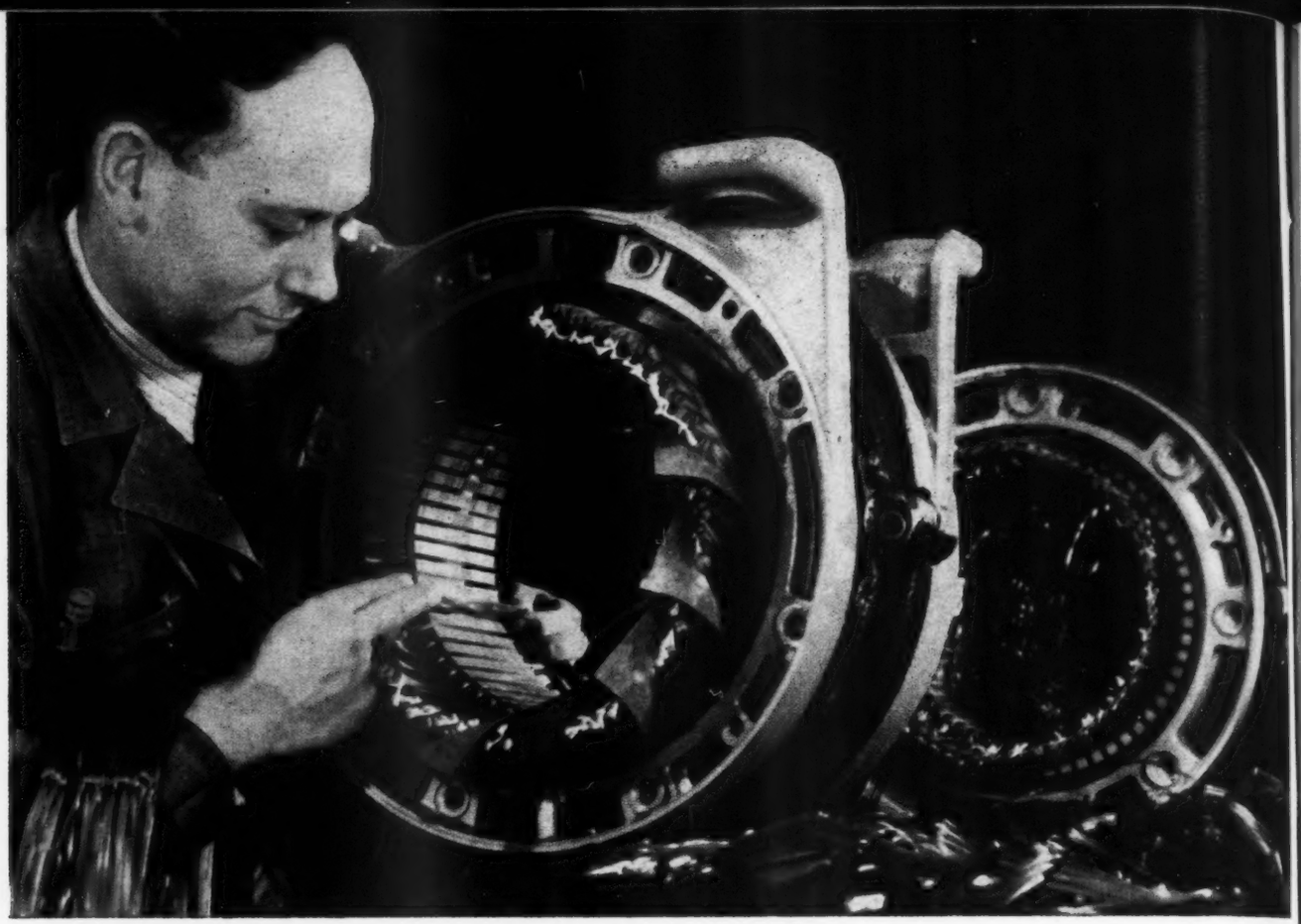
When asbestos insulation was developed by U. S. Motors there was no manufacturing plant in the country which offered the facilities for processing asbestos fibre suitable for U. S. Motors application. No manufacturer of ordinary insulation was equipped, either with machinery or knowledge, to make asbestic material of the kind required, so it was necessary for the U. S. organization to devise means for processing this material.

The pure asbestos is first treated to render it moisture-proof. Sheet asbestos is cut and molded to conform with the perimetrical shape of each stator slot. Die-cut shapes are made to fit between coils and between phase windings where coil ends are nested.

The impregnating compound, Asbestosite, is produced by reducing asbestos fibre rock to a very fine powder. This asbestos base is held in colloidal solution with high volatile diluents which are driven off after the compound permeates the windings.

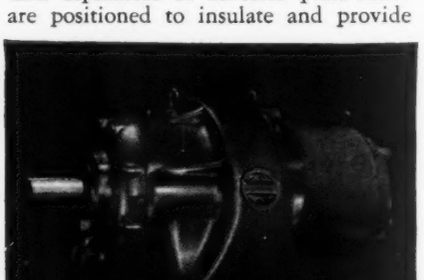
Through baking and particular curing means, the Asbestosite is hardened and forms a solid, intimately attached to and isolating every turn of windings.

Asbestos-protection is an exclusive U.S. Motors feature, pioneered, patented and perfected by U.S. engineers. It's the answer to long motor life. *Request Bulletin.*

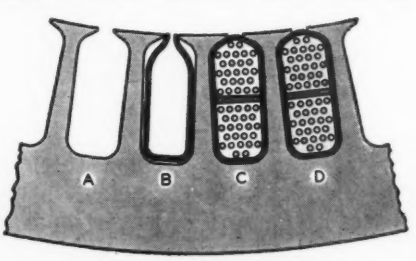


BUILDING ASBESTOS INTO U.S. MOTORS

The heart of a motor is its hottest spot. Asbestos is used in U. S. Motors to protect the windings against heat. Barrier walls of asbestos are inserted in each stator slot. Coil separators of asbestos plate-board are positioned to insulate and provide heat-proof walls between coils in each slot. The lips of the asbestos barrier between the wires and the steel are overlapped at the tooth tips. This forms a cell of sheet asbestos between the copper windings and the steel core. Then the stator is submerged in an impregnating tank of Asbestosite. The latter penetrates the windings and surrounds each wire with a coating of asbestos. An interrupted current is passed through the windings to gently vibrate and isolate each wire.

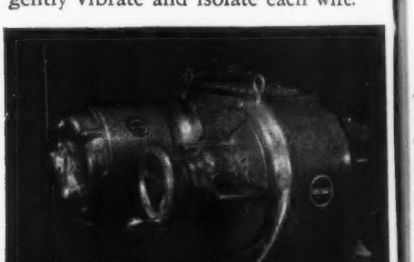


U. S. Horizontal Syncrogear Motor



U. S. ASBESTIC PROCESS

(A) Empty stator slot. (B) Formed cell of Asbestos. (C) Windings inserted. (D) Asbestosite (indicated in color) penetrates every interstice.



U. S. Horizontal Varidrive Motor

The QUALITY LINE of Power

VARIDRIVE MOTORS	*for infinite speeds*
SYNCROGEAR MOTORS	*for multiplied power*
UNICLOSED MOTORS	*Horizontal and Vertical*
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AUTOSTART *Grinders and Buffers*

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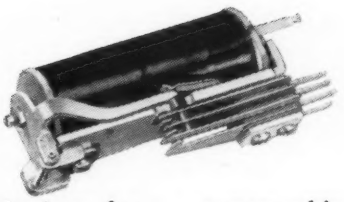
Who said—

Remote Control is a Problem?



DESIGN problems that involve electrical remote control quickly fade when you take advantage of Automatic Electric's experience. That's because electrical control has been Automatic's sole business for over fifty years. During that time, they have not only designed and manufactured relays, stepping switches, and a wide variety of other control apparatus—but have also gained the experience necessary to adapt these devices to countless needs.

Next time you are faced with an electrical design problem involving remote control, switching, selection, counting, signaling or quality control, try calling in the Automatic Electric field engineer. Helping customers whip such problems is his everyday job.

In the meantime, be sure you have a copy of the new Automatic Electric catalog of "Relays and Other Control Apparatus." You'll find it the most complete guide to the selection and use of control devices ever published. We'll be glad to send a copy without charge.

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AND OTHER CONTROL DEVICES
by **AUTOMATIC ELECTRIC**

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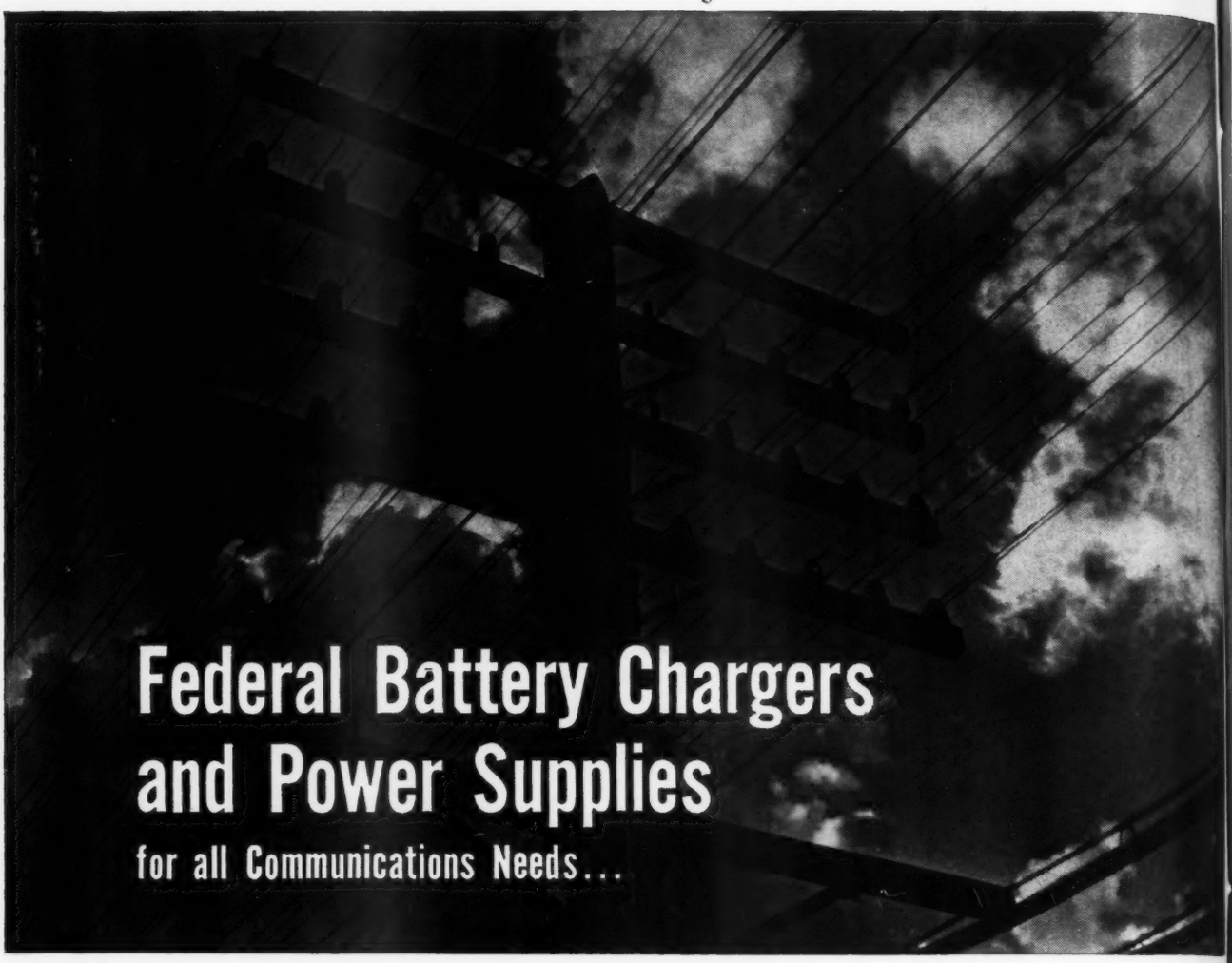
PARTS AND ASSEMBLIES FOR EVERY ELECTRICAL CONTROL NEED



Federal Battery Chargers and Power Supplies

for all Communications Needs...

. . . powered by I.T.&T. Selenium Rectifiers

Typical Automatic Noiseless Telephone Battery Charger

Built for highest efficiency and powered by long-life I. T. & T. Selenium Rectifiers, Federal Battery Chargers and Power Supplies are available in all types and sizes, in a wide range of ratings, to meet every communications requirement — telephone, telegraph, signaling and alarm systems. The many types include automatic regulated noiseless chargers and battery eliminators, manually operated units and non-filtered types.

Federal Battery Chargers and Power Supplies provide important operating advantages: no routine maintenance; no radio interference; hum-free output; high overall efficiency. They are for use on commercial AC circuits; they are rugged and compact and have a minimum of critical materials.

The "power unit"—the I.T.&T. Selenium Rectifier introduced and manufactured by Federal — is standard in the electrical field. Its freedom from moving parts, its wide temperature operating range, its capacity for overload and unlimited life, assure stable and satisfactory performance. *Consulting engineering services available from Department E.*

Federal Telephone and Radio Corporation

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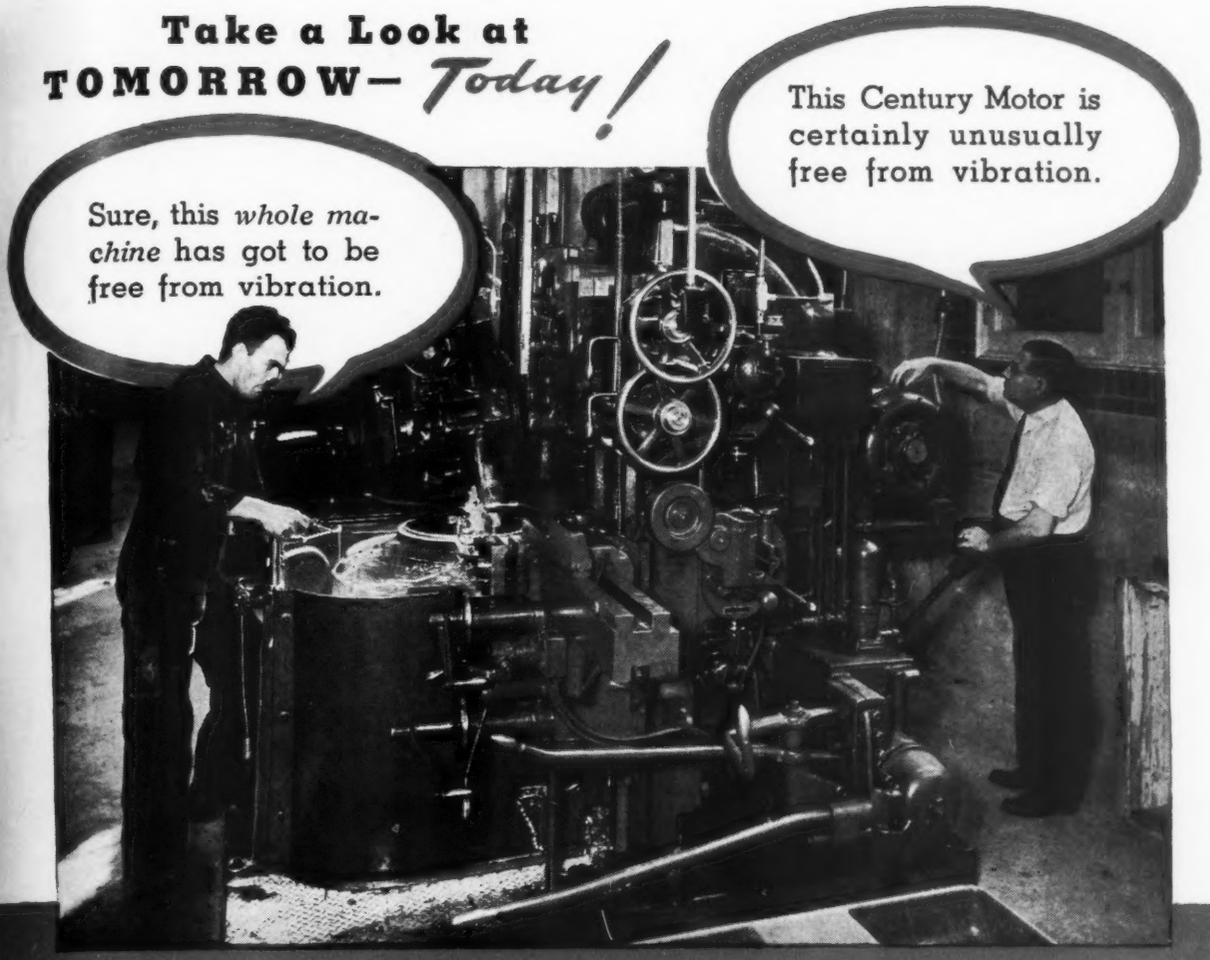
Take a Look at TOMORROW— *Today!*


Sure, this *whole machine* has got to be free from vibration.
This Century Motor is certainly unusually free from vibration.

CENTURY MOTORS' Unusual Freedom From Vibration Contributes to More Accurate Machine Tool Performance

The unusual freedom from vibration of Century Motors matches the precision and accuracy of the thousands of machine tools they drive.

Determine for yourself — put your fingertips on a Century Motor and you'll hardly realize it's running — because of its quiet operation and solid feel.

When tolerances must be held to the closest limits, the rotational balance of Century Motors is all-important, including:

- Magnetic Balance
- Mechanical Balance
- End Bumpers
- Rugged Frames
- Accurately Machined Feet
- Extreme Rigidity

Every contribution to precision workmanship, to increasing the speed of production and decreasing the number of rejected pieces is particularly important today under the demands of War. It is important, too, in peacetime production, as tolerances grow finer and advanced engineering demands extreme precision work.

Today and tomorrow, the unusual freedom from vibration of Century Motors grows increasingly important. It will pay you to remember Century for practically all your future motor applications — from fractional to 600 horsepower.

CENTURY ELECTRIC CO., 1806 Pine St., St. Louis 3, Mo.

Offices and Stock Points in Principal Cities

Century MOTORS 345

Eliminate Soldering... WITH *Burndy* HYDENT

Speed Work-flow...Cut Costs

Connectors

Burndy . . . pioneer in solderless electrical connectors...is working closely with leading designers and manufacturers in applying the economies and advantages of indent type connectors to component parts manufacture, and final assembly. In most cases, standard HYDENT connectors are used; in others, Burndy has designed special connectors for the job. In *all* cases, the indent type connection has simplified and stepped-up production, provided a better connection mechanically and electrically, and materially lowered costs.

If you are still using soldered connections, why not investigate thoroughly the advantages of the solderless indent type? Complete engineering cooperation is yours for the asking . . . from connector headquarters. Write or phone to-day.

BURNDY ENGINEERING CO., INC.
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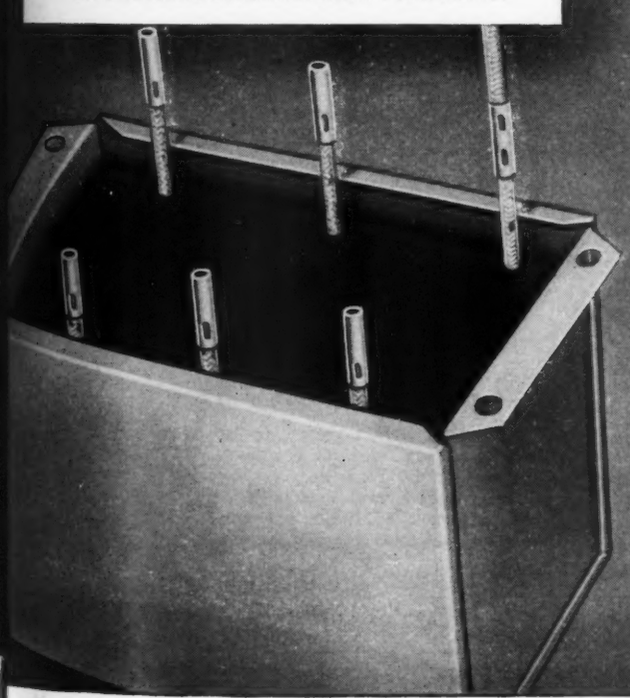
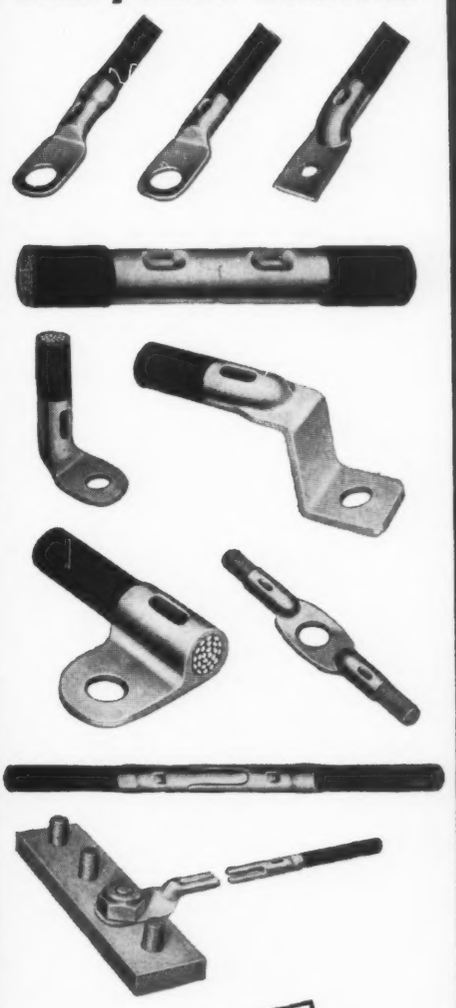


A few of the many types of
Burndy HYDENT CONNECTORS



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Burndy

Peerless MOTORS
Standard and Special
★ SINGLE PHASE
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FIFTY years in the production of quality electrical equipment have given Peerless engineers and craftsmen proficiency and experience in designing and building motors of maximum efficiency and trouble-free operation.
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PEERLESS GOLDEN JUBILEE
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THE PEERLESS ELECTRIC CO.
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Have you considered Carbon Seal Rings? Does your application demand low friction, long wearing and non-abrasive qualities? We have developed special carbons to meet varying conditions of pressure, temperature, speed, and character of material to be sealed. Our engineers are available for consultation on your sealing problems. Bulletin sent on request.
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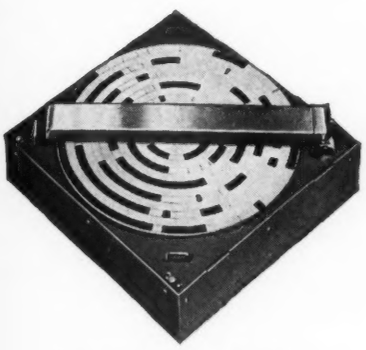

AUTOMATIC PROCESS CONTROL

This new development by the research laboratories of General Electronics Industries provides automatic control of chemical processes and also of production machinery, by means of printed charts which may be replaced or interchanged as readily as phonograph records.

● Jacks-of-all-trades have their place . . . but *not* in General Electronics Industries. Everyone in this organization, from top-flight research engineers to service men and their assistants, is an electronics specialist.

We have no miracle gadgets nor mysterious cure-alls for sale. Our business is the proper application of electronics to solve individual production problems. This begins with diagnosis, *follows through* with research, perhaps special design, and includes expert service before and after completion of the job.

To assist you in your post-war production planning, one of the largest organizations specializing in Electronics offers the skill, experience and unsurpassed facilities that have successfully met the most exacting tests of war.

Write to Engineering Department, General Electronics Industries, 342 West Putnam Avenue, Greenwich, Connecticut.

Other products manufactured include: ELECTRONIC CONTROLS • VACUUM TUBES • HYDRAULIC SERVOS COMMERCIAL RADIO EQUIPMENT • ELECTROMECHANICAL DEVICES • ELECTROSTATIC HEATING UNITS UP TO 250 KW.

ARMY-NAVY "E" WITH STAR awarded to Auto-Ordnance Corporation for continued excellence in production of "Tommy" Guns.

GENERAL Electronics INDUSTRIES

Division of Auto-Ordnance Corporation

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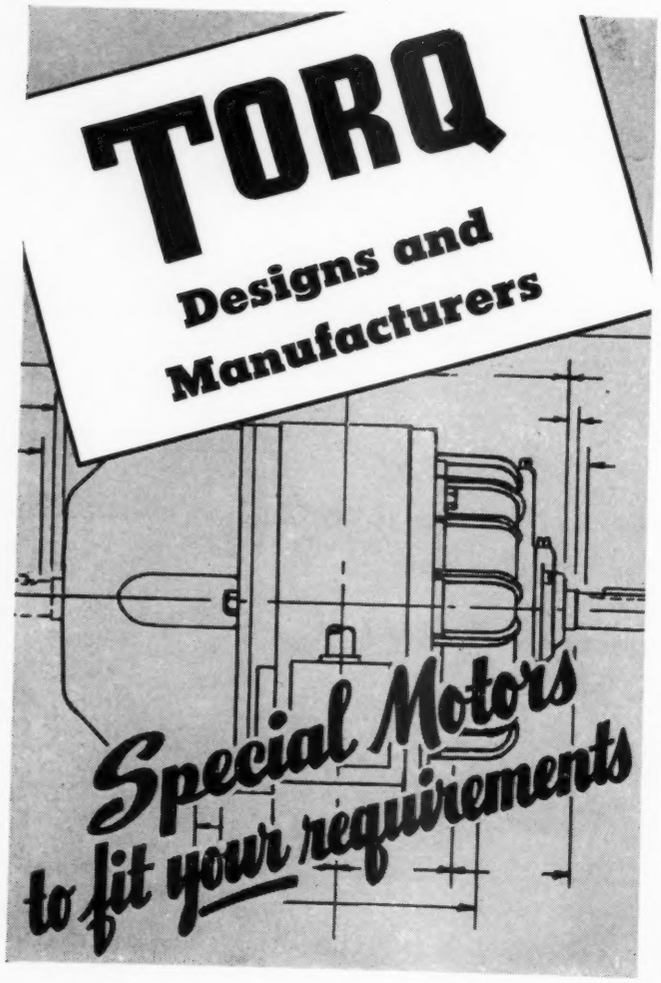

Is your problem one of designing a special motor or motor mounting to fit your product? Then consult TORQ today! Specialized engineering experience . . . up-to-the-minute "know-how" . . . complete manufacturing facilities . . . these are at your service, to help you speed production—save time and money. Write today, explaining your problem. We can furnish motors engineered to your needs!

For users of standard motors, sizes from 1 to 20 H.P. are available for immediate delivery.

THE TORQ ELECTRIC MANUFACTURING CO.
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The fourth in a series of plastics applications

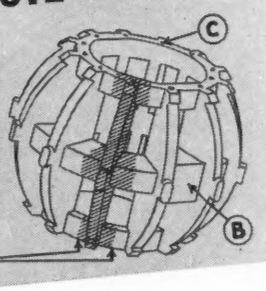
Molded to Carry Commands Across Continents . . .

RADIO . . . the voice of our Armed Forces . . . the medium of direct, speedy communications . . . uses many plastic parts, one of which is this radio coil form.

Twenty-seven years of molding experience at Aico has paved the way for plastics engineering of intricate parts, resulting in high-speed, economical war production and an important saving of vital material.

RADIO COIL FORM

Molded from 13017 Bakelite for LOW-LOSS; HEAT RESISTANCE



13017 BAKELITE RADIO COIL FORM

MOLDING MATERIAL

Thermosetting 13017 Bakelite, mineral filled phenolic compound, was selected for this intricate part because (1) phenolic compounds are easy to mold into complicated shapes and (2) mineral filled phenolics have a low power factor—provide high electrical resistance in products where low-loss is a paramount consideration.

MOLD DESIGN

The coil form, one of the largest pieces molded in this material, weighs approximately 1 lb. and requires a 700 lb. steel mold of complicated construction and containing many individual pieces. Designed by Aico and built in Aico's well-equipped Tool Room, the mold is comprised of twelve sections which join (at points A) to form a spherical part. Two of the sections vary in design, forming two thicker wall sections (B) on opposite sides of the piece. The piece is molded complete; no machining operations are necessary.

MOLDING METHOD AND PRODUCTION

Aico, equipped for all kinds of molding, chose the transfer method for this part because it is best suited for intricate shapes, particularly where tolerances in the direction of molding are important. The mold is one cavity, semi-automatic. Due to the thick wall sections (B), this piece requires a 12 min. molding cycle, with a production of 5 pieces per hour. The only finishing necessary is removal of gates (C).

A request will bring additional copies of file cards Nos. 1–4 as a handy reference for plastics applications.

AICO

Aico PRECISION MOLDING

AMERICAN INSULATOR CORPORATION, New Freedom, Pa.
Sales Offices: BOSTON · BRIDGEPORT · BUFFALO · CHATTANOOGA
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*SPECIAL MOTORS DESIGNED TO FIT THE APPLICATION

EXTREME QUIETNESS AND LONG LIFE

If operating conditions were always the same . . . if there were no differences in types and sizes of the product — there would be no need for special motors. But we know that variables do occur in equipment, such as oil burners, and other electric motor operated apparatus, which require specially designed motors to meet specific performance requirements of compactness, quietness, overload protection and long life. Holtzer-Cabot special motors are meeting the operating conditions in various types of equipment.

Holtzer-Cabot has concentrated its energies in the specialized business of designing and building special fractional HP motors for every purpose.

Our engineers, backed by 68 years of motor design, can help you with your motor problems.

THE HOLTZER-CABOT ELECTRIC COMPANY

Designers and Builders of Special Fractional HP Motors and Electrical Apparatus

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THIS RELAY IS SMALLER HUSKIER AND COSTS LESS!

The design of the Ward Leonard Little Giant Single Pole Relay is simplicity itself. It is sturdily built yet there is not an ounce of material in it that is not essential to efficient performance. Measures only $1\frac{7}{8}$" x $2\frac{5}{8}$". Controls $\frac{1}{4}$ H.P. on 115-230 volts. Ideal for heaters, pumps, compressors, signal lights, etc. Described in Bulletin 105.

(WL) Relay Bulletins

Little Giant Relays	Bulletin	105
Midget Relays	"	106
Intermediate Duty Relays	"	81
Heavy Duty Relays	"	131 & 132
Sensitive Relays	"	251
Time Delay Relays	"	351 & 362

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Electric control (WL) devices since 1892.

RELAYS • RESISTORS • RHEOSTATS

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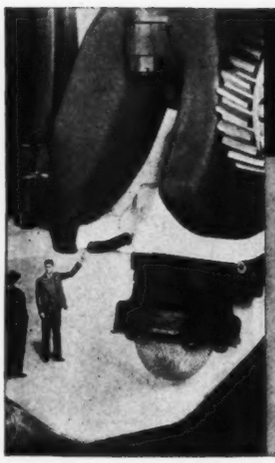

NO GREASE OR OIL FITTINGS

on

WISCONSIN HEAVY-DUTY AIR-COOLED ENGINES

In today's war production set-up, even the saving of fractional manpower for servicing grease cups and oil fittings is important. And neglect of this attention can mean serious damage to irreplaceable production equipment. This can't happen with Wisconsin Engines because there are no grease cups or oil fittings; no lost manpower; no chance for human error or carelessness. Wisconsin Engines are protected by positive force-feed and splash lubrication.

MOST POWER Per POUND

WISCONSIN MOTOR Corporation
MILWAUKEE, WISCONSIN, U. S. A.
World's Largest Builders of Heavy-Duty Air-Cooled Engines

SOCKETS

ENGINEERED BY *Cole-Hersee*
For New Type of Lamp Bulbs

With COLE-HERSEE improved BEAVER (Pat. Pend.) Contact Construction. Or can be furnished with wire leads and bracket or mounting construction to suit your needs.

No. 2344
Socket for Indexing Base

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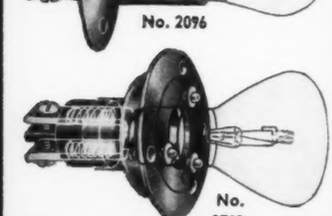

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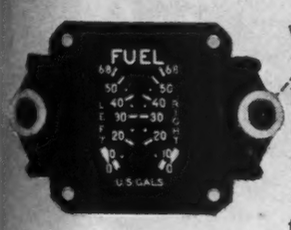
Quality Electrical Automotive and Aviation Equipment

If you have a problem in switch or socket application bring it to Cole-Hersee for prompt action.

Cole-Hersee Company
54 OLD COLONY AVE. BOSTON, MASS.

time to go home



When the red warning signal flashes from the Liquidometer Low-Level Indicator, the pilot knows only a few minutes' flying time is left. Our airmen's lives depend upon the unfailing accuracy of little things like these. "They're always dependable", says Liquidometer, about their products. Manufacturers of precision instruments must rely on their sources of supply. That's why Liquidometer entrusts the making of contacts, and nickel-silver pins to Callite.

CHECK ALL FOUR

When seeking the four factors vital to your production, precision engineered parts; expert metallurgical and engineering advice and supervision; consistent deliveries with ability to meet emergencies; top quality at a fair price - you will find all four at Callite Tungsten Corporation, 551 Thirty-ninth Street, Union City, N. J. Branch Offices: Chicago, Cleveland.

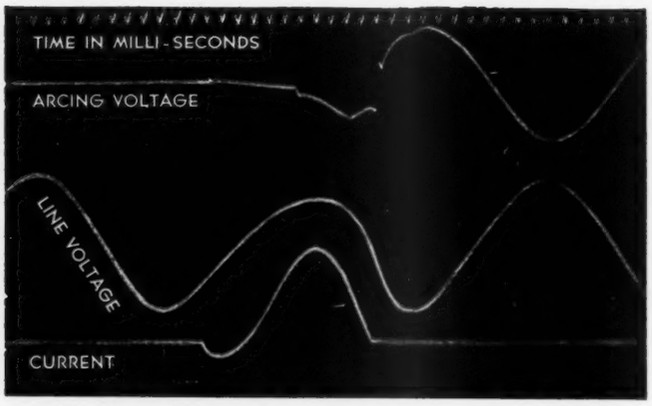
Callite Contacts

CALLITE TUNGSTEN CORPORATION CT

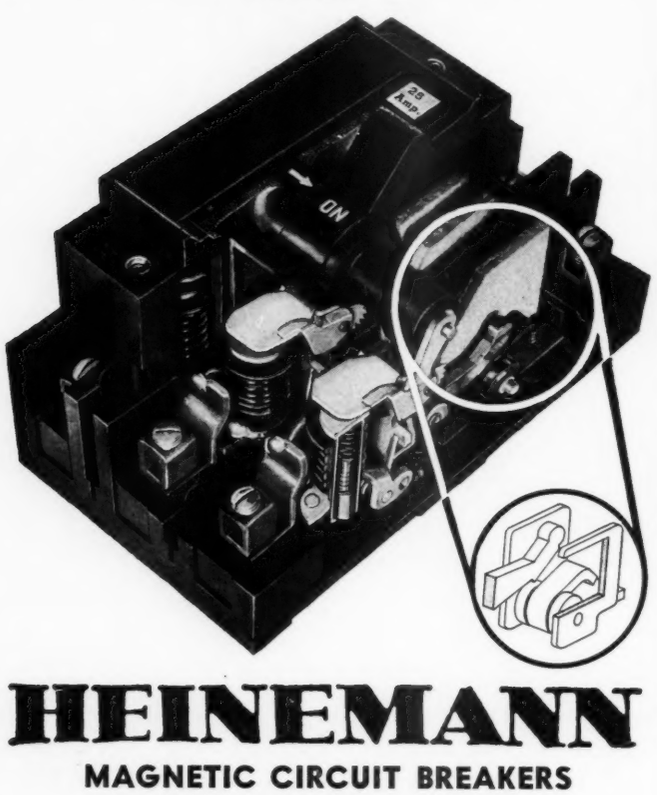
Formed parts and electrical contacts in standard and special shapes—of tungsten, molybdenum, silver, platinum, palladium, and alloys. Send for catalog 152.

Ever see a picture of a

SHORT CIRCUIT?



Oscillogram taken on a 50 ampere breaker showing short circuit with 6450 amperes rms flowing through the breaker which interrupted within ½ cycle on 120 V AC with a power factor of approximately 60%. This was the third operation on a circuit having a capacity of approximately 8000 amperes rms.



HEINEMANN

MAGNETIC CIRCUIT BREAKERS

Employ High Speed Blowout

The stationary contact is coiled around an insulated iron core which connects the steel plates forming a U-shaped magnet. On overloads and short circuits the current flowing through the contact creates magnetic lines which force the arc into the arcing chamber and blow it out. As the value of the current to be interrupted increases the quenching effect becomes greater due to the intensified magnetic blowout field.

Send for Catalog 40 showing full line

HEINEMANN CIRCUIT BREAKER CO.

Subsidiary of Heinemann Electric Co.

Est. 1883

109 PLUM STREET — TRENTON, N. J.

PRECISION TO THE "Nth" DEGREE

Perfect co-ordination of skilled minds and hands in a well knit organization with 20 years of radio manufacturing experience has been the secret of MERIT'S success in building precision equipment to the most exacting specifications.

Now manufacturing tor every branch of the Armed Services.

Suppliers of component parts for the famous SCR-299 mobile unit

Since 1924

Transformers — Coils — Reactors — Electrical Windings of All Types for the Radio Trade and other Electronic Applications.

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311 North Desplaines St. — CHICAGO 6, U. S. A.

It's New!

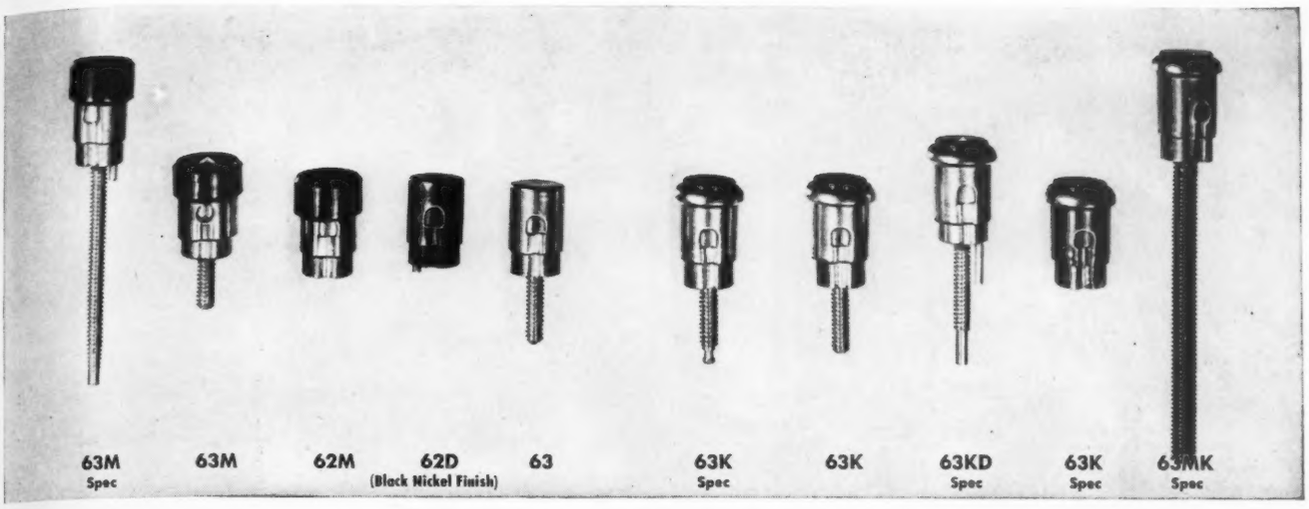
MODEL L-32 MOTOR-GENERATOR

Operates on 6v. d.c. input (12-, 24-, or 115v. available). A.C. output 1-, 2- or 3-phase. Standard aluminum-housed model includes speed regulator and resistance. Speed control 1% for 25% variation in input or load. Delivers 27v. 2-phase a.c. at 2400 R.P.M. Weight 32 oz.; 6¼" x 2" dia.; 5/16" shaft with 1" extension.

Special models of fractional h.p. motors and generators built to your requirements.

ELECTRIC INDICATOR CO.

115 PARKER AVE. — STAMFORD, CONN.



EBY SPRING BINDING POSTS

ASSURE A POSITIVE VIBRATION-PROOF CONTACT!

1. The spring — unseen but most important, is designed for long life with minimum pressure loss in service — corrosion resistant.
2. The "D" shaped hole grips the finest wire and holds it in perfect contact. This special Eby construction gives correct, uniform tension across the entire surface of the wire.
3. Eby spring posts have dual guides — makes positive alignment of insertion holes.
4. Made from the highest quality material to meet rigid manufacturing standards and assure maximum electrical conductivity.
5. Recognized standard finishes are nickel, silver, black nickel, and cadmium.
6. Insulating bases, shields, bushings, and spacers in bakelite and ceramic.
7. Cap markings are supplied such as: ANT; REC; GND; HI; A; C; Line; —; +; L1; L2.
8. Most items are carried in stock in sufficient quantity to assure quick preliminary deliveries.

Eby Spring Binding Posts are made to a traditional standard of quality and workmanship, backed by years of experience and a long list of satisfied users. The actual styles shown are illustrative of the wide variety and the great possibility of the use of Eby Spring Binding Posts.

A BINDING POST FOR EVERY USE!

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EBY
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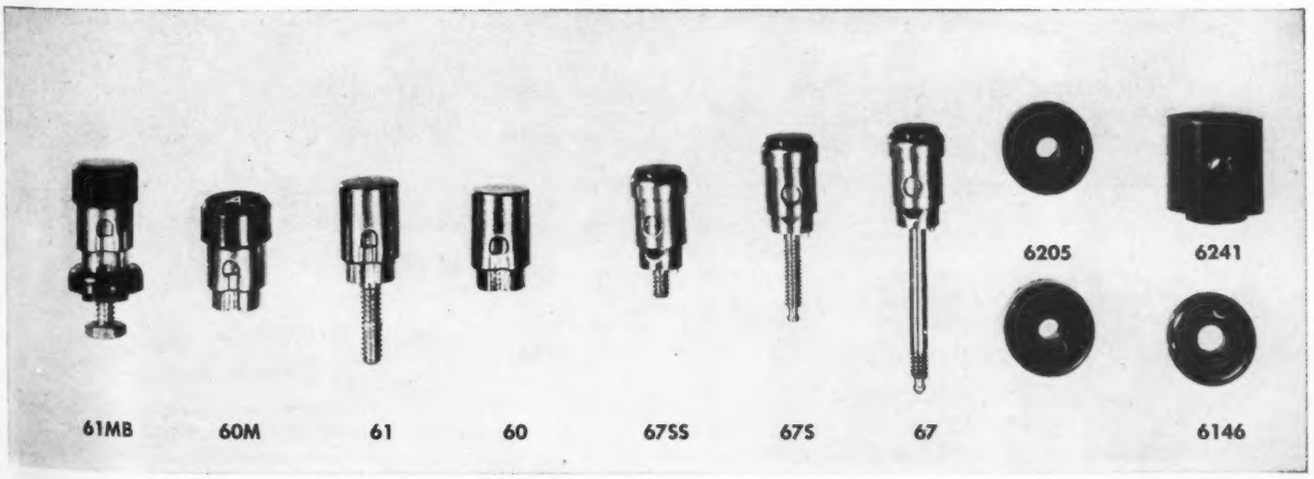
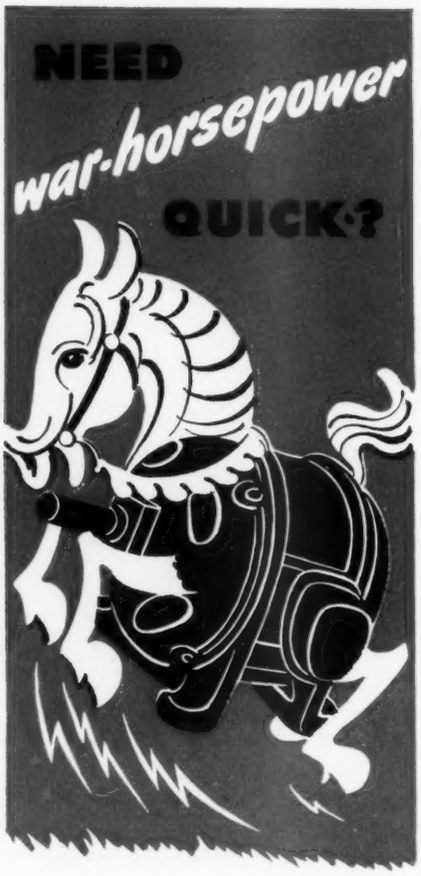




ask Westinghouse!

...the one best way to find the one best motor for the job

Chances are that out of the many motors we're now making for battle service, we've got one to fit your needs. If not—Westinghouse is ready to design a new one or to adapt an existing type to fit your job . . . *and do it without false starts or lost motion*. Our experience in matching motors to battle jobs is at your disposal. Call or write your nearest Westinghouse office. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., Dept. 7-N. J-21290

Westinghouse
MOTORS AND CONTROL

★ **Actuating Elements**

FOR TEMPERATURE RESPONSIVE DEVICES

Engineered from thermostatic bimetals, in shapes and of a type to meet your specific needs. Chace utilizes 25 different alloys to produce 35 different types of thermostatic bimetals.

FOR Wartime Products

Chace Thermostatic Bimetals are regularly used in vital control instruments for aircraft, tanks, trucks, cars, jeeps and numerous other implements of war requiring temperature responsive device.

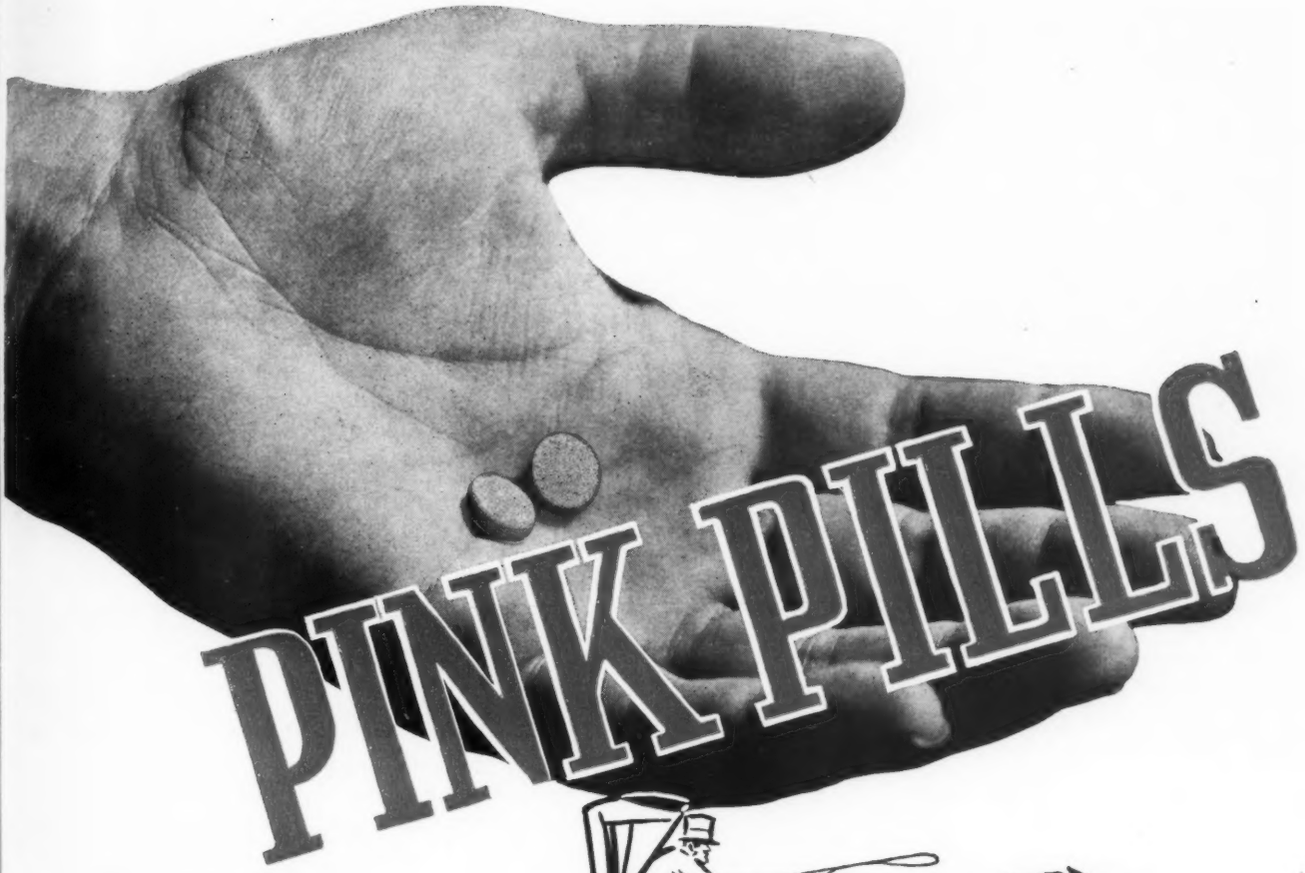
FOR Civilian and Post-War

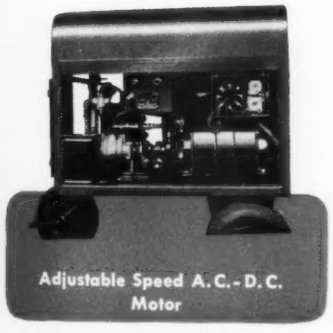
To you manufacturers who will soon be producing the essential civilian products that require automatic temperature controls, and to you who are now planning post-war products that call for thermostatic actuating elements. . . . Two new types of thermostatic bimetals and three important manganese base alloys have been developed by and added to the W. M. Chace Company line of products.

●

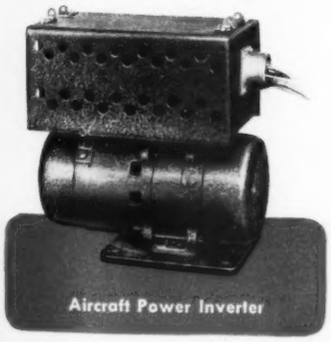
Chace Thermostatic Bimetals are sold in shapes ready for assembly, also completed assemblies with terminals attached. Data sheets and engineering assistance cheerfully furnished on request.

W.M. CHACE CO.
Manufacturers of
Thermostatic Bimetals and Special Alloys
1607 BEARD AVE • DETROIT 9, MICH.

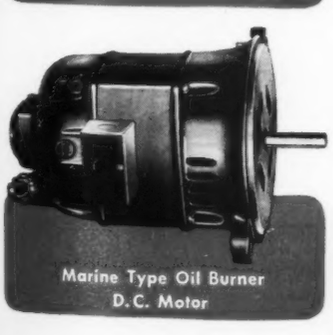




Adjustable Speed A.C.-D.C. Motor



Aircraft Power Inverter



Marine Type Oil Burner D.C. Motor

● Gone are the days of the "old family doctor," the man who gave you little pink pills for everything and performed any and all operations. Today, doctors are specialists. The same is true in other fields.

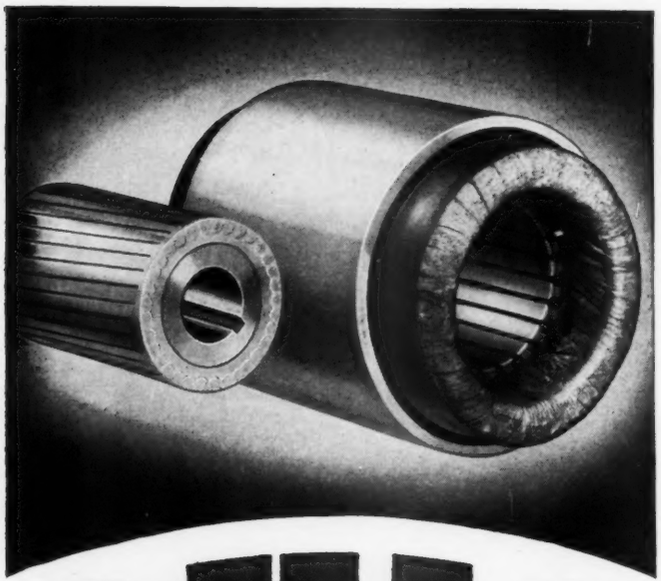
● The Leland Electric Co., through the "University of Hard Knocks," have become specialists on power generators. Their engineers have the "knack," plus the engineering skill, to produce power generators that are "tops." That skill is now being utilized by Uncle Sam . . . on land, in the air and on the seas.

● After the war, Leland will continue to emphasize the development of power generators for peacetime requirements. They invite you to consult them now on your post-war power generator problems.

THE LELAND ELECTRIC CO., DAYTON, OHIO

Leland

FOR BETTER DESIGNED POWER GENERATORS



OHIO

Shell Type MOTORS

Compact and Efficient

Design is often facilitated and efficiency increased by making the motor an integral part of the machine or appliance. This type is particularly suitable where one of the motor speeds available is directly applicable to the purpose.

The stator is pressed into a heavy steel shell and the rotor is bored to your specifications. Rotor is dynamically balanced on a test shaft with key in place.

Ratings range from ¼ to 7½ HP; speeds, 1150, 1750 and 3500 rpm. Built for A.C. single-phase or multiphase currents.

OHIO MOTORS INCLUDE

Split-phase Induction to ⅓ HP
Direct Current to 1 HP
Capacitor to 2 HP
Polyphase to 2 HP
Aircraft Motors
Shell Type to 7½ HP
Torque to 100 oz. ft.
Shaded Pole to 1/30 HP
Synchronous to ¼ HP
A.C. to D.C. Motor Generators to 500 watts.
High to Low Voltage D.C. Dynamotors up to 300 watts.

Tell us your requirements and we will advise with you

THE OHIO ELECTRIC MFG. CO.
5911 Maurice Avenue Cleveland, Ohio

Range −100° F to +600°F
Sensitivity ± 1/10° F
Size 4½" over-all with 5/8" shell

The Thermoswitch

COUPLING HEAD

The most compact, convenient thermal control available. Write

Fenwal INCORPORATED
30 MAIN ST.
ASHLAND
MASSACHUSETTS

AN *All-Electric*
ADJUSTABLE-SPEED DRIVE
FOR A-C. CIRCUITS
SPEED RANGES UP TO 16 TO 1
SIZES—1 TO 30 hp.

RELIANCE VS DRIVE

1 **DIRECT DRIVE.** Lower cost, because fewer parts (no intermediate speed-changing device). Power is closer to where it is needed. Use less space. Streamline your machine design.

2 **SPEED CONTROL CONVENIENCE WITHOUT LIMITATIONS.** Place speed-changer and start-stop button at any convenient point to which a wire can be run. Control always within easy reach.

3 OPERATES ON A-C. POWER.

4 QUICK STOPPING.

5 SMOOTH, FAST ACCELERATION.

6 REVERSING.

7 SPEED-SETTING.

8 SLOW FOR THREADING and INCHING.

Get Reliance Bulletin 311 for details—and other advantages.

RELIANCE ELECTRIC & ENGINEERING CO.
1088 IVANHOE ROAD • CLEVELAND, OHIO
Sales-Offices in Principal Cities

A STRONG FAMILY—

AND THIS MOVING FINGER MECHANISM FITS THEM ALL

These "3C" Bulletin 101 Master Switches are built to stand active service in heavy duty operation.

Roller Bearings on Type RD; Oilite Bearings on Types S2D and Types S4D; accurately molded Impact Bakelite Cams; sturdy steel shafts; Double Break Silver-to-Silver Contacts; and the same Moving Finger Mechanism is interchangeable in all types.

The Contact Bar is easily removed; Pressure Springs will not fly out, being held in place by a large end spring ring, which bears against the cage.

All these features and many more make for low-maintenance on these devices.

Write for fully descriptive "3C" Bulletin 101 Master Switches.

CONTINUE TO ROLL WITH CLARK CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, OHIO

K·C MOTORS

anticipate the needs of tomorrow

K-C Capacitor Start Induction Motors, designed for high starting, accelerating and maximum torques; ¼ to ¾ H.P., 1725 R.P.M. and up to 1½ H.P. 3600 R.P.M.

Ability of K-C Motors to meet today's strenuous conditions with efficiency, economy and long-lived stamina is being proved on a wide range of applications. Outstanding performance under these conditions points to the all-'round adequacy of K-C Motors for the needs of the future when low-cost operation will be a highly important factor in appraising motors for built-in service.

Types, sizes and dimensions of K-C Motors are contained in catalog available on request.

K-C

KINGSTON-CONLEY ELECTRIC COMPANY

86 BROOK AVENUE,
NORTH PLAINFIELD, N. J.

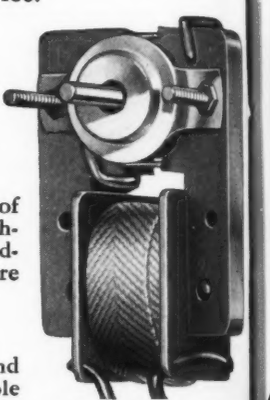
1,001 USES

Condensed Power for Years of Service

VERSATILITY and dependability were paramount when *Alliance* designed these efficient motors—*Multum in Parvo!* . . . They are ideal for operating fans, movie projectors, light home appliances, toys, switches, motion displays, control systems and many other applications . . . providing economical condensed power for years of service.

Alliance Precision

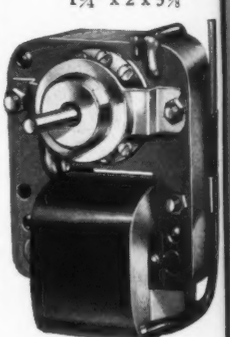
Our long established standards of precision manufacturing from highest grade materials are strictly adhered to in these models to insure long life without breakdowns.



Model "MS"—Full Size Motor Measures 1¾" x 2 x 3⅛"

EFFICIENT

Both the new Model "K" Motor and the Model "MS" are the shaded pole induction type—the last word in efficient small motor design. They can be produced in all standard voltages and frequencies with actual measured power outputs ranging upwards to 1/100 H. P. . . Alliance motors also can be furnished, in quantity, with variations to adapt them to specific applications.



New Model "K"—Full Size Motor Measures 2⅛" x 2⅜" x 3⅛"

DEPENDABLE

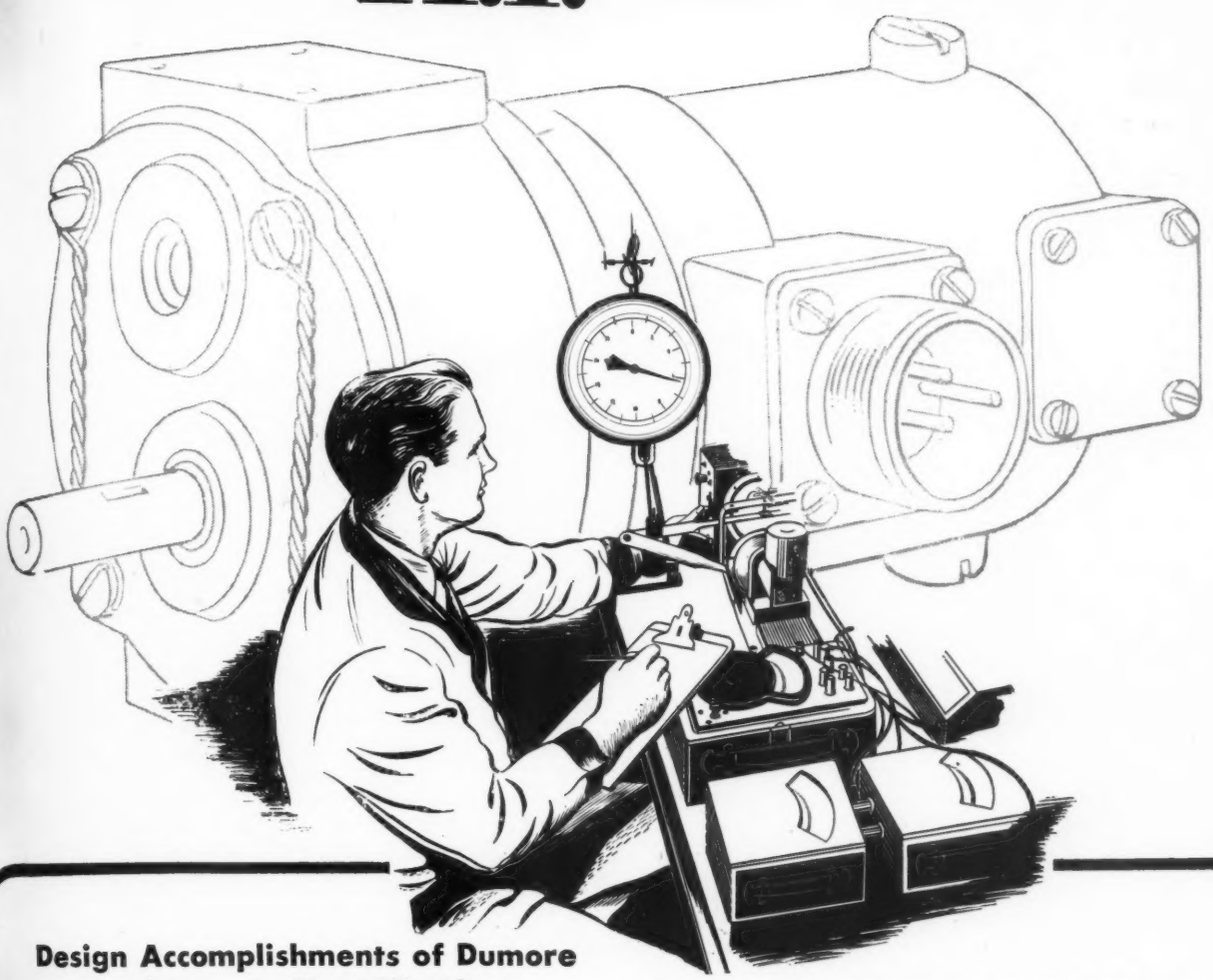
Both these models uphold the *Alliance* reputation for all 'round dependability. In the busy post-war period, there will be many "spots" where these Miniature Power Plants will fit requirements . . Write now for further information.

Remember Alliance!
—YOUR ALLY IN WAR AS IN PEACE

ALLIANCE MANUFACTURING CO.

ALLIANCE . OHIO

MORE H.P. PER OUNCE!



Design Accomplishments of Dumore Engineers to Meet Wartime Requirements Open Broad Field for Peacetime Products

War's challenge to the engineer has been met; wartime production acceleration has telescoped years of revolutionary motor design into a few short months. At Dumore, this challenge has had special dramatic emphasis, because the task of bettering previous achievements in fractional horsepower motor design for aircraft accessory actuators was a tangible, if modest, part of the achievement of American and Allied supremacy in the air.

Smaller, lighter motors with the same power or more — incorporation of efficient brakes, clutches and reduction gears under near-impossible weight and space restrictions — special brushes and lubrication for dependable operation over wide altitude, temperature and humidity ranges — these and a score of other assignments were set up for and successfully met by Dumore engineers. As a result of this comprehensive design experience — product engineers can design the motor driven devices they are planning for post war manufacture around Dumore motors, which are vastly improved over those they knew in "the old days."

Product designers will find it advantageous to become acquainted *now* with the advanced design of the Dumore motors they will be using tomorrow — with the compact shapes, the light weight, the stepped-up horsepower and the wide variety of design modifications which will give new standards of service—new performance versatility—new sales appeal to motor-driven products tomorrow.

Dumore engineers welcome your inquiry and the opportunity to aid you in making wider use of these new Dumore motors. Write today! The Dumore Company, Motor Division, Racine, Wisconsin.

Dumore *Headquarters for*
FRACTIONAL HORSEPOWER MOTORS

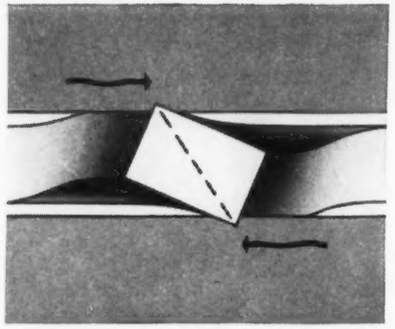
"MOTOR-PLAN" YOUR POST-WAR PRODUCTS — NOW!

SHAKEPROOF LOCK WASHERS

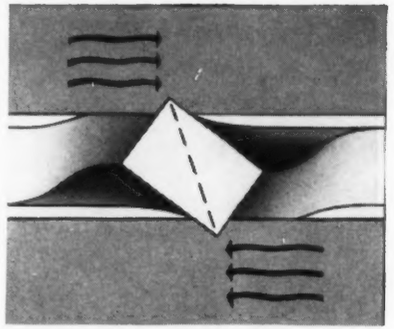
Actually Lock Tighter under Vibration!

REASON: STRUT-ACTION PLUS SPRING-TENSION

ARMY E NAVY



A tight strut-action lock is produced by each tapered-twisted tooth at initial contact!



Under vibration, spring-tension forces teeth to bite deeper and increases locking power

Powerful multiple tapered-twisted teeth biting into both surfaces provide positive vibration protection for any screw or nut connection!

WRITE FOR FREE TEST KIT

SHAKEPROOF inc.

Distributor of Shakeproof Products Manufactured by ILLINOIS TOOL WORKS

2501 North Keeler Avenue, Chicago 39, Illinois

Plants at Chicago and Elgin, Illinois • In Canada: Canada Illinois Tools, Ltd., Toronto, Ontario

Distributor of Shakeproof Products Manufactured by ILLINOIS TOOL WORKS
2501 North Keeler Avenue, Chicago 39, Illinois
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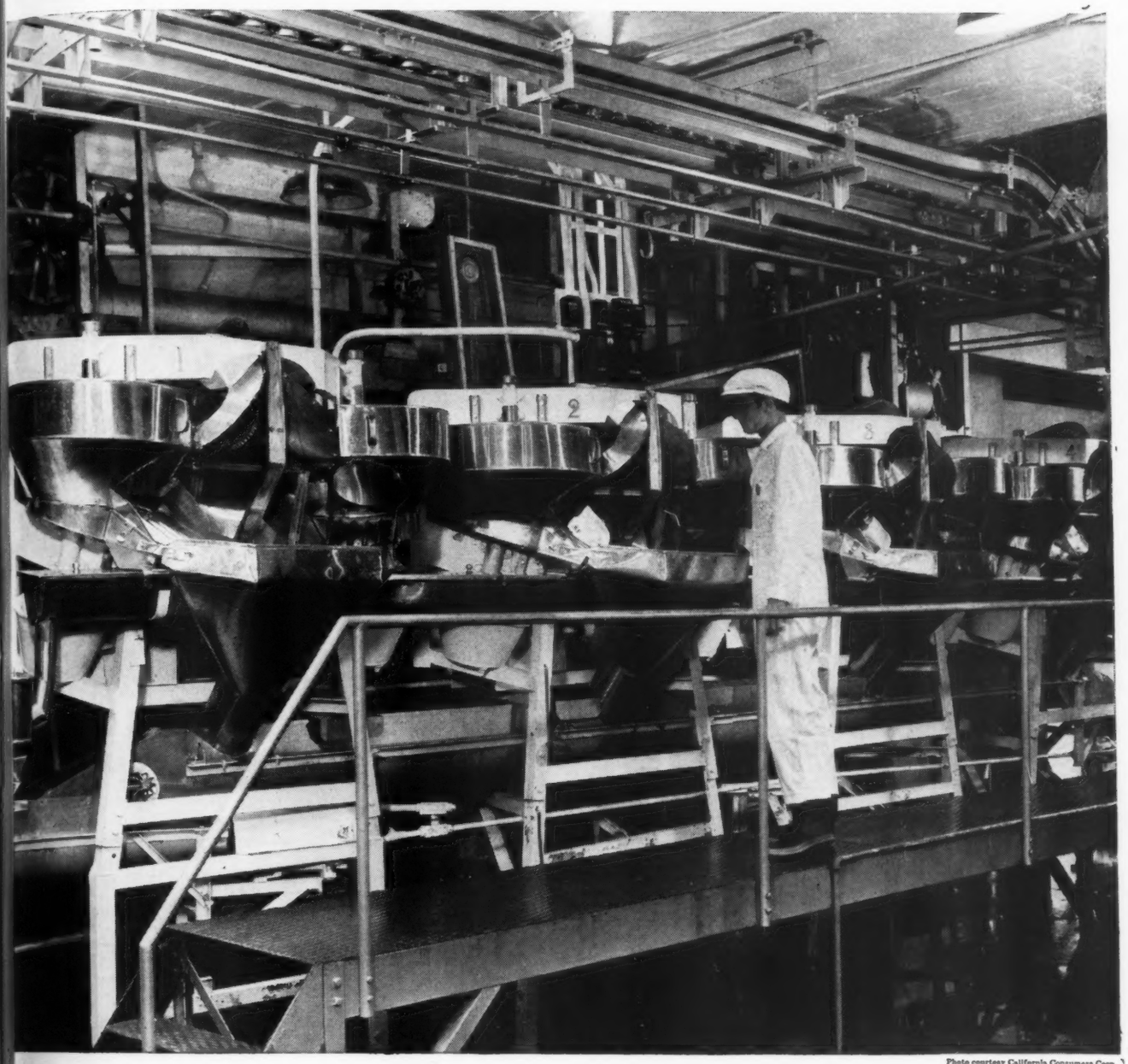


Photo courtesy California Consumers Corp.

It's a juicy job for Koroseal

A typical example of B. F. Goodrich product development

EVERY second—enough orange juice for a family of twenty. In an hour—72,000 oranges or lemons cut and squeezed. That was the goal for this group of big juice extractors. But the little rubber cups that held the fruit against the squeezer couldn't stand the oils and acids in the rinds. The rubber swelled; changed shape and made the pressure on the fruit uneven so that all the juice was not extracted.

Some material had to be found that was flexible enough to hold the fruit at just the right pressure. It had to resist the action of the oil and acid in the skins of all citrus fruits. And most important of all, it must not impart the slightest odor to the juice.

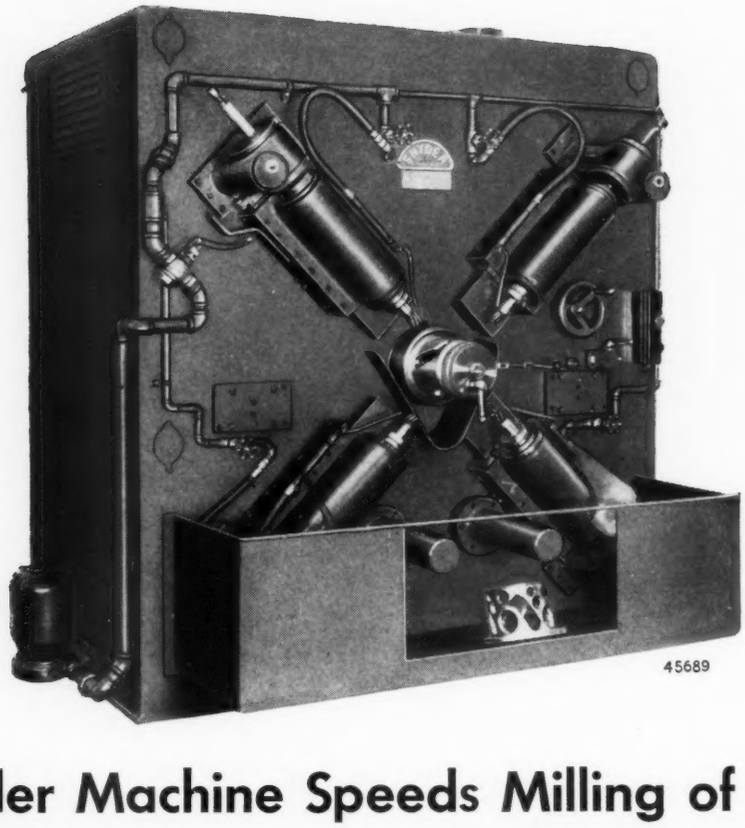
B. F. Goodrich had developed Koroseal, a flexible material made from limestone, coke and salt. Koroseal has been used as a waterproof coating for cloth and paper, as a lining for acid tanks, and in places where resistance to oil was needed. Cups made of Koroseal were tried in the juicer. They were impervious to oil and acid, and did not impart any odor to the juice. Today each machine turns out 150 gallons of untainted juice an hour.

Koroseal is now being used in essential war applications and can't be sold for home use. But it's available for essential industrial uses, and limited amounts can be used for experiment. Write us if you have any problem which Koroseal might solve. *The B. F. Goodrich Co., Koroseal Division, Akron, Ohio.*

Koroseal Reg. T. M.

B.F. Goodrich

RUBBER *and* SYNTHETIC *products*



Snyder Machine Speeds Milling of Slots on Cams of Urgently Needed Propellers

With a production of seven cams an hour at 80% efficiency, this Snyder "special" has increased importantly the output of urgently needed aircraft propellers.

Developed for finish (or rough) milling four cam slots in each cam, the machine is equipped with four spindles to mill all four slots at one time. Spindles are mechanically inter-connected (each has its own hydraulic cylinder) and go through rapid approach and feed into the work in small steps while the work piece reciprocates and rotates in conformity to the master cam. For smooth cam-follower operation, the master cam is designed with a rise-to-length ratio of one in five. Cam movement is integrated with the motion of the fixture.

Infeed on tools, per reciprocation of part, is adjustable over a wide range of from .010″ to .150″. The spline mill principle of feeding the tools into the work step by step results in excellent finish and good tool life.

Tool spindles are driven from electric motors through v-belts and worm wheel drive and are mounted on precision tapered roller bearings, allowing take-up for possible wear.

Fixture spindle and slide are hydraulically actuated and provide two feed rates—one for the cut through the shallow angle of the cam slot and a slower rate for the steeper portion of the slot. All hydraulic controls are adjustable and are located inside the machine to prevent tampering once they are set. Fixture spindle is mounted on preloaded tapered roller bearings, insuring rigid mounting and vibrationless operation of the machine. Provision is made for take-up on the pre-load.

A similar machine developed for rough milling the slots would eliminate the step by step infeed of the cutters and cut the slots in one pass, leaving from $\frac{1}{16}$″ to $\frac{1}{8}$″ of stock in the slots for finishing.

ABOUT YOUR POST-WAR PLANS...

For 20 years Snyder has been cooperating with leading industries in devising special-purpose machines and methods for fast, economical, high-quality production. This experience is at your service NOW to help you prepare for profitable post-war production and re-employment, both so essential to post-war prosperity. Write in full confidence.

SNYDER TOOL & ENGINEERING COMPANY
3400 East Lafayette — Detroit 7, Michigan

SNYDER
DESIGNERS AND BUILDERS OF MACHINERY FOR HIGH PRODUCTION AT LOW UNIT COST

Installing a 48" PD "C" section 8 groove QD Sheave on a 7" stroke horizontal air compressor. The QD Sheave weighs 440 pounds, about four times the girl's weight.

A NEW DESIGN

...SPEEDS ASSEMBLY, REDUCES BEARING STRESSES, STAYS TIGHT ON THE SHAFT AND FITS ALL APPLICATIONS

Military and industrial design engineers everywhere have acclaimed the New Worthington Q.D. (quick detachable) Sheave with its superior operating and maintenance advantages, as the guarantee against long delays and costly shut-downs when assembling or repairing Vital DriveR and DriveN machinery.

The Q.D. Sheave construction principle incorporates a split hub that is easily positioned on the shaft. The tapered rim is pulled up on the tapered hub with pullup bolts. When detaching the rim from the hub, the pullup bolts are used as jack screws and inserted into the tapped holes in the rim. This New Sheave Design is your assurance of a positive fit on the shaft, yet EASY TO GET ON AND EASY TO GET OFF... and that applies to those Giant Driven Sheaves often weighing thousands of pounds, as well as the smaller driver.

No engineering changes are necessary to design the Q D. Sheave into your products.

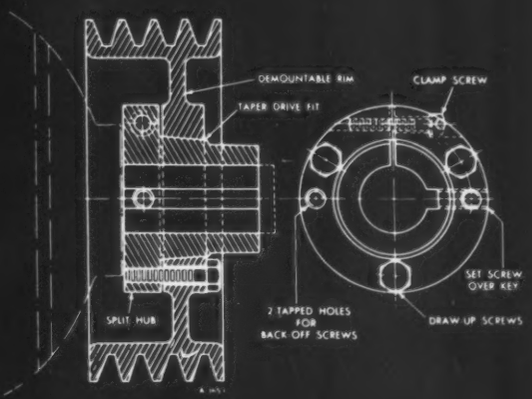
Investigate today. **Q. D. Sheave features are found in no other sheave on the market today and they cost you no more. Arrange for your demonstration of the Q. D. principle today. The Worthington district office engineer in your area will gladly call at your plant.**

WORTHINGTON
MULTI-V-DRIVES

COMPLETE DRIVES — SHEAVES OR BELTS ONLY

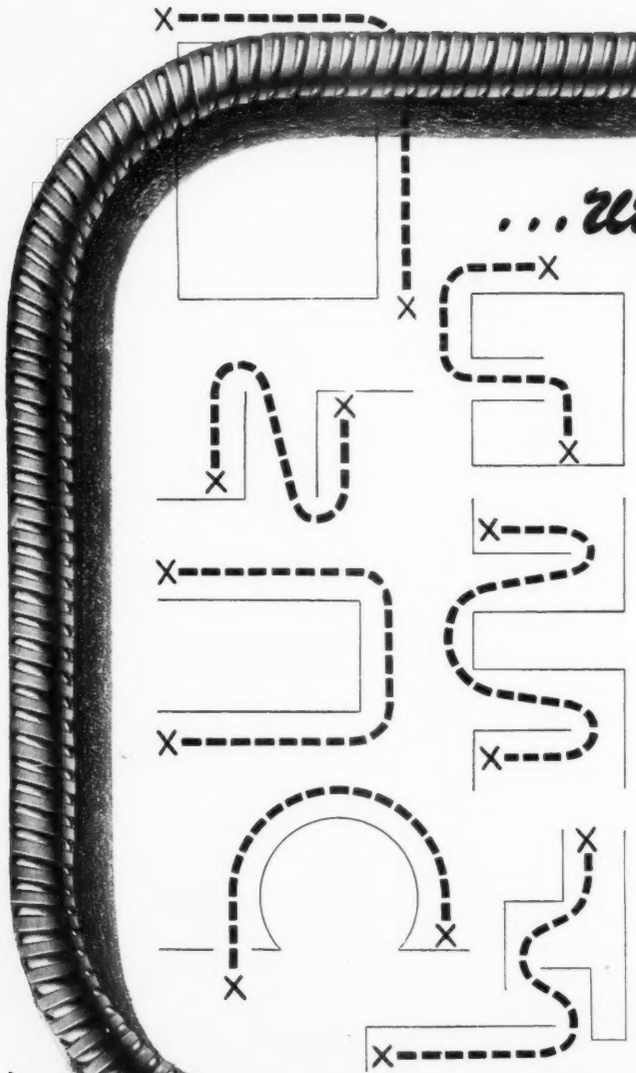
WORTHINGTON PUMP & MACHINERY CORPORATION
GENERAL OFFICES: HARRISON, N. J.

IMPROVE YOUR PRODUCTS WITH WORTHINGTON QD (QUICK DETACHABLE) SHEAVES



WRITE FOR THE NEW Q.D. SHEAVE BULLETIN

When the shortest distance is *NOT* a straight line

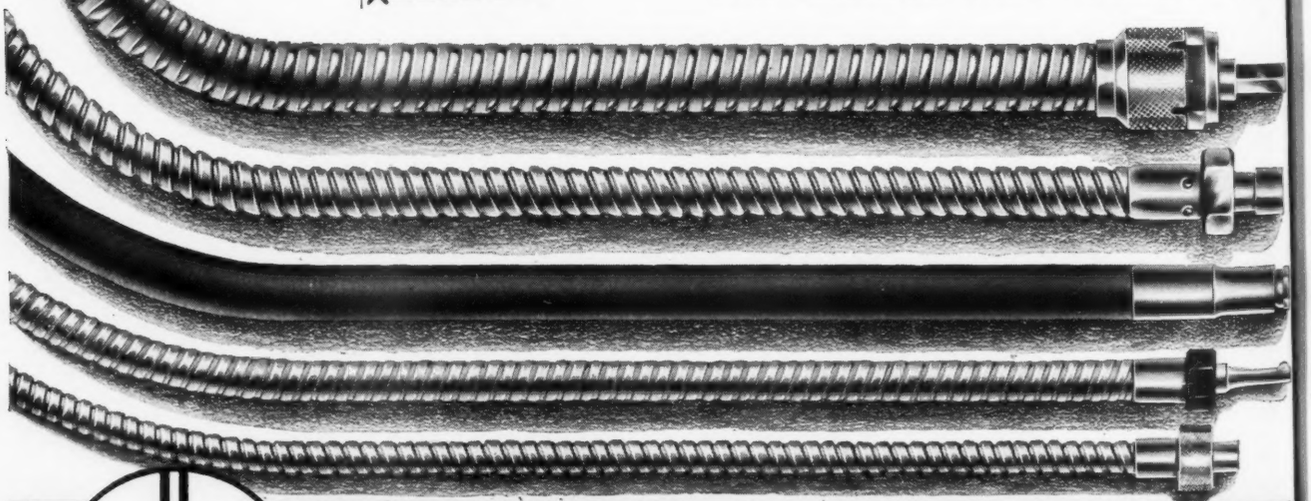


...use WALKER-TURNER FLEXIBLE SHAFTING

When the shortest distance for transmission of power or control between two points is not a straight line — specify Walker-Turner Flexible Shafting.

Designed and made entirely in our own plant, Walker-Turner Flexible Shafting has been thoroughly job-tested in thousands of our flexible shaft machines. From our broad experience in its manufacture and application, we have been able to render valuable assistance to aircraft manufacturers and other producers of war equipment. Perhaps the transmission problem that your engineering department is trying to solve, has been worked out by us for other concerns. Why not ask us?

WALKER-TURNER COMPANY, INC.
44123 BERCKMAN STREET • PLAINFIELD, N. J.



walker-Turner
COMPANY, INC.
PLAINFIELD, N.J.
U.S.A.

FLEXIBLE SHAFTING

FOR REMOTE CONTROL AND POWER TRANSMISSION

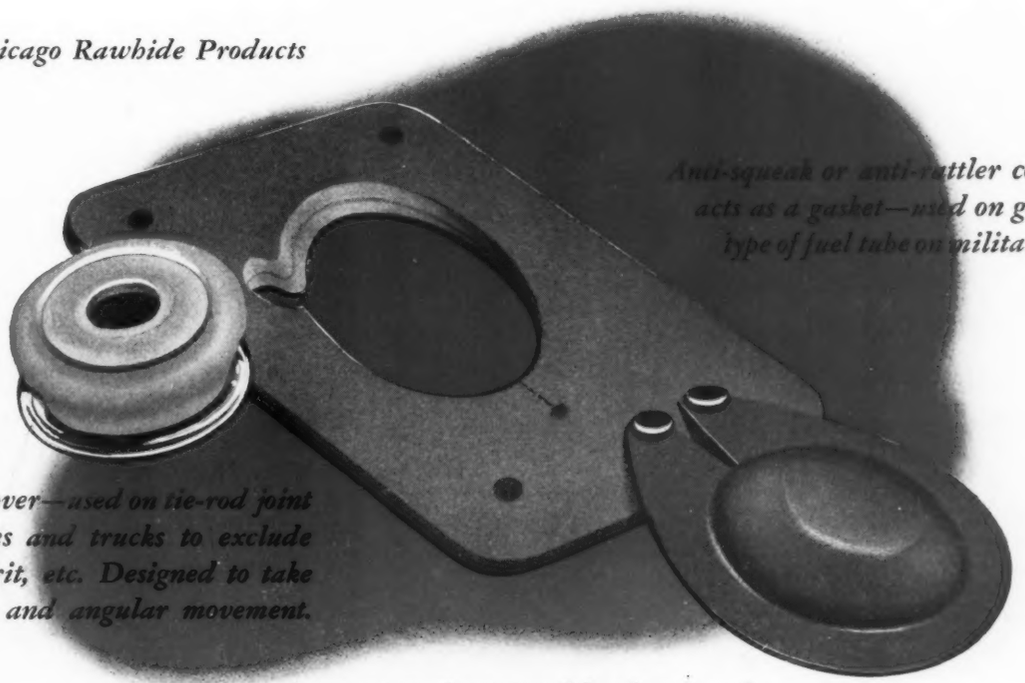
Do it better with Leather

LEATHER is in a class by itself! It has been the answer to many important problems of mechanical application in the past, will solve many more in the future.

Here at Chicago Rawhide—never content to let well enough alone, we are constantly seeking something better, improving old products and creating new ones, always looking ahead.

That is why—for 60 odd years, leading concerns, both large and small, have come to us with complete confidence. They know that our engineering, research and production experience assures them of the most efficient and best possible products for their specific requirements.

Interesting Chicago Rawhide Products



Anti-squeak or anti-rattler cover that acts as a gasket—used on goose-neck type of fuel tube on military trucks.

Boot or dust cover—used on tie-rod joint on automobiles and trucks to exclude dirt, sand, grit, etc. Designed to take both rotating and angular movement.

Ear phone cover of retanned leather—used by pilots, navigators, radiomen, etc.

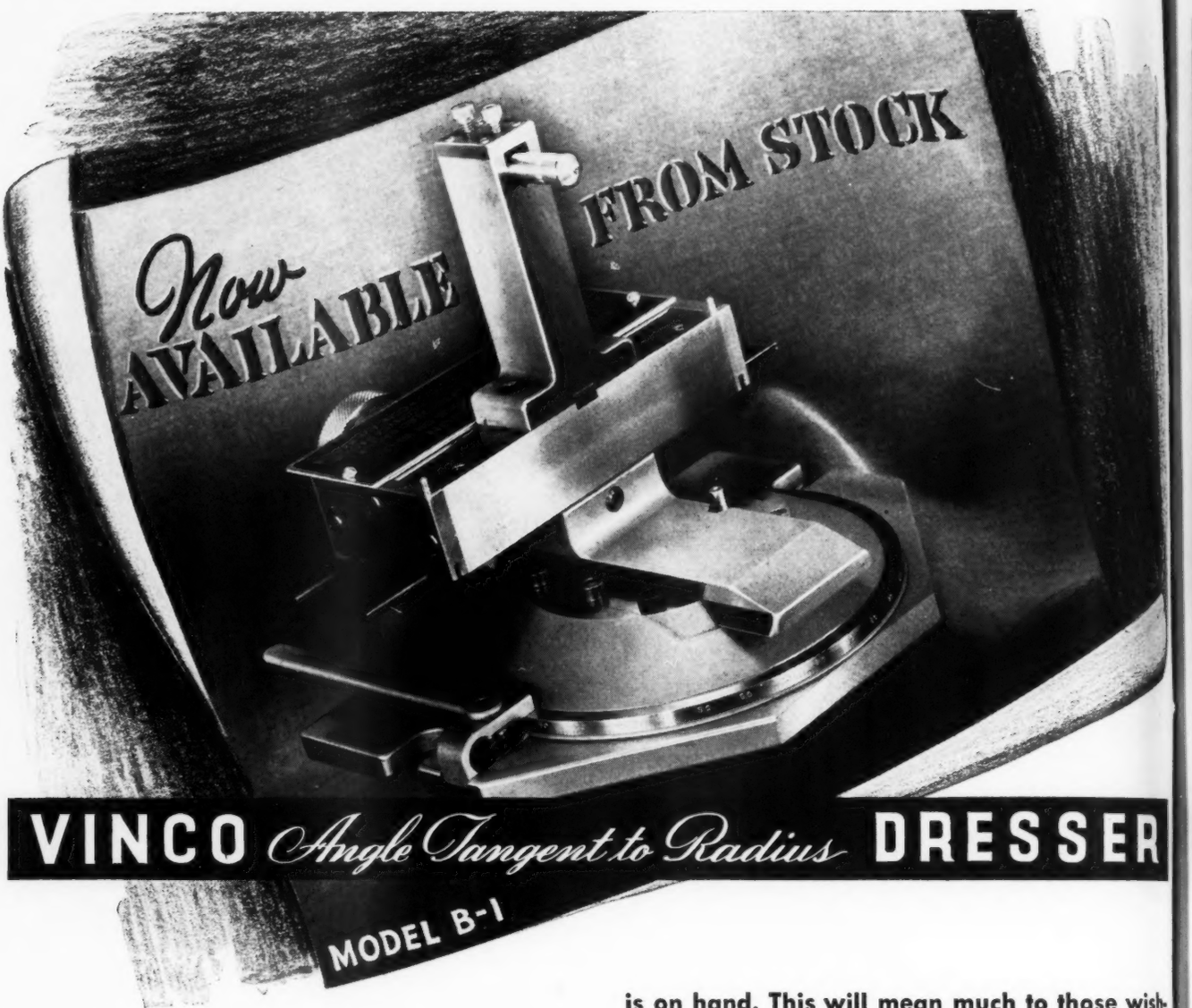
CHICAGO RAWHIDE MANUFACTURING CO.

Established 1878

Manufacturers of Leather and Synthetic Rubber Products for Mechanical Application

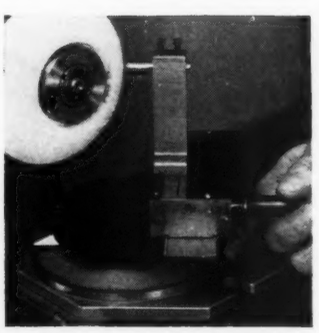
1301 ELSTON AVENUE, CHICAGO, ILLINOIS

DETROIT • NEW YORK • PHILADELPHIA • LOS ANGELES • PITTSBURGH • BOSTON • PEORIA • SYRACUSE • CLEVELAND • CINCINNATI



Since the VINCO B-1 DRESSER (angle tangent to radius) was designed and its manufacture started, the boss of the Dresser Department, Jimmy Allen, has made it his personal business to see that each and every Dresser was built with VINCO precision throughout.

The demand for this sturdy little Dresser has been increasing—and VINCO has increased manufacturing facilities accordingly. Production has gradually gained until now an adequate stock of Dressers is on hand. This will mean much to those wishing immediate delivery.



But in spite of the increased production, the quality of the Dresser still remains VINCO quality—precision built into every part.

The VINCO B-1 Dresser has almost universal applications; and with the care generally given precision tools, its service, under ordinary production conditions should be long and economical.

Write for the B-1 Folder which contains full details.

VINCO CORPORATION, 8857 SCHAEFER HIGHWAY, DETROIT 27, MICHIGAN

MILLIONTHS OF AN INCH FOR SALE BY VINCO

SCAIFE TANKS
FOR WATER, AIR AND GASES

★ ARC WELDING—hand, automatic or semi-automatic.
★ BRAZING—SPOT WELDING.
★ DRILLING and TAPPING.
★ HOT-DIP GALVANIZING.
★ PRESSURE TESTING.
★ DRAWING and STAMPING.
★ HOT or COLD RIVETING.

PRECISION-BUILT...*to your specifications*-
MASS PRODUCED...*for speed and economy*-

Many manufacturers have found that they save time, cut costs and get a better job by letting SCAIFE design and build their tanks, cylinders and pressure vessels.

Years of rich experience covering thousands of designs of containers for water, air and gases, has given us a wealth of knowledge that is available to you.

You can use these facilities NOW—to your definite advantage!

FOUNDED SCAIFE 1802

SCAIFE COMPANY
(FOUNDED 1802)
General Offices and Works: OAKMONT (Pittsburgh District), PA.
REPRESENTATIVES IN PRINCIPAL CITIES

CASE STUDY —

Connecting metal tubing where there is major vibration . . . .

THE PROBLEM

An oil filter manufacturer required tubing connections for installation of filters. Due to flexible engine mountings these connections—extending between oil filter and crankcase — had to be able to stand up under major vibration. Rigid tubing lines connected with ordinary fittings frequently failed. Flexible lines had the disadvantages of shorter life and high cost because of the long lengths required. A satisfactory fitting for use with rigid (steel) tubing lines was sought.

THE SOLUTION

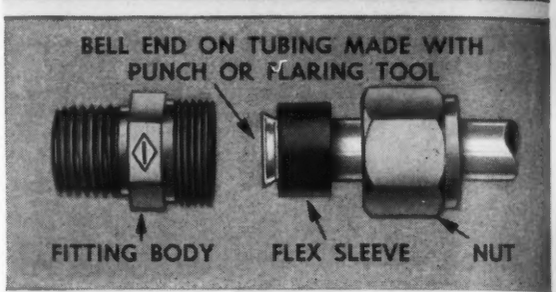
A newly developed, revolutionary Imperial fitting, the Flex Fitting—especially designed for use in joining parts which vibrate in different planes and amplitudes—was submitted to this filter manufacturer.

This fitting has a synthetic rubber sleeve incorporated which not only effects a seal but also provides a cushion which permits tubing to absorb vibration without damage to fitting or tubing itself.

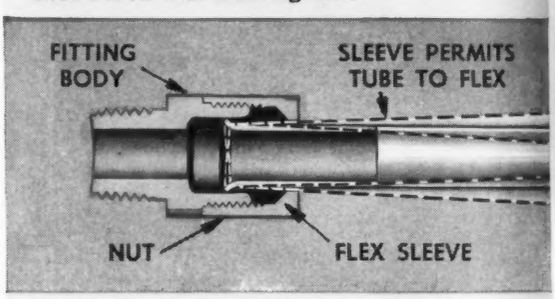
Exhaustive tests in the field by filter manufacturer proved the Flex Fitting was the practical answer to their needs. Advantages of the Flex Fitting in this instance were:

(1) Solved problem of tubing failure due to major vibration.
(2) Cut costs as compared to flexible lines.
(3) Provided greatly increased durability as compared to flexible lines.

In your product planning, whenever fittings for connecting tubing are involved, our broad experience in solving fitting problems can often be of assistance. There are over 2,000 sizes, types and styles of fittings—designed to meet virtually any need—in the complete Imperial line.



The view above shows a Flex fitting ready for assembly. The nut and the Flex sleeve have been slipped over the end of the tube and the tube has been belled with a flaring tool.



The sectional view shows the Flex fitting after assembly. Note that belled end of the tube does not contact the body. The Flex sleeve squeezes against the end of the fitting body and is compressed against the tube, making a joint that is pressure tight and yet the tube can be flexed through the angle shown.

THE IMPERIAL BRASS MANUFACTURING CO., 515 S. Racine Ave., Chicago 7, Ill.

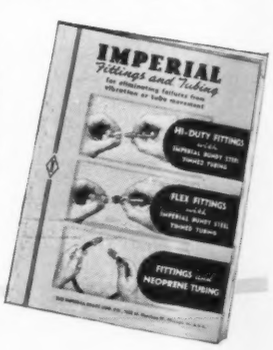
IMPERIAL

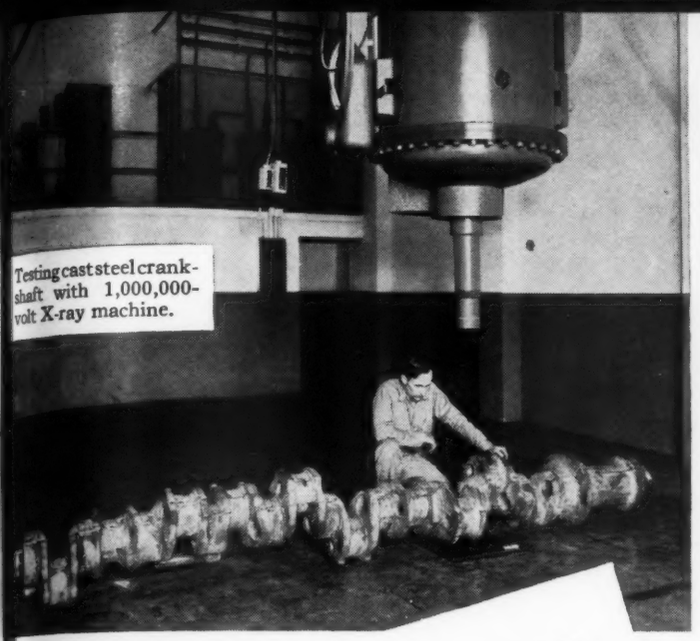
★ *headquarters for tube fittings*

COMPRESSION, S.A.E. FLARE, INVERTED FLARE, HI-DUTY, FLEX AND FN FITTINGS FOR COPPER, BRASS, STEEL, ALUMINUM AND FLEXIBLE TUBING • SHUT-OFF COCKS • NEEDLE VALVES • FUEL STRAINERS • TUBE WORKING TOOLS

BULLETIN NO. 3101 covers the latest practice in tubing connection work where minor vibration, major vibration or actual tube movement enter into the problem.

A copy will be mailed on your request

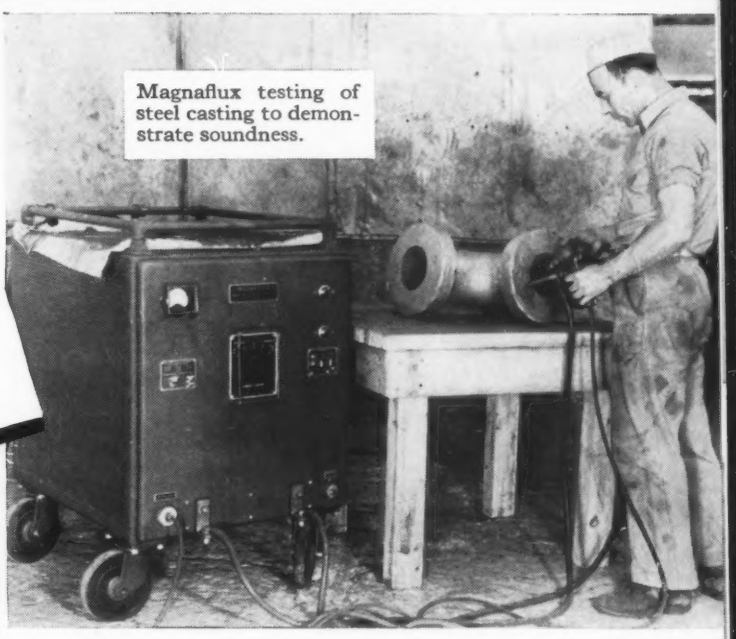




Testing cast steel crankshaft with 1,000,000-volt X-ray machine.

Gamma-ray testing group of steel castings using radium capsule.

STEEL CASTINGS *Twice-proved*



Magnaflux testing of steel casting to demonstrate soundness.

It's a lot tougher for a steel casting to "get into uniform" than for a man to qualify for Army or Navy. The tests are more exacting—a greater degree of perfection is demanded.

Steel Castings have no difficulty in proving their soundness and fitness for duty—first by passing through rigid magnaflux, gamma ray or million-volt X-ray tests, and then by standing up in service, no matter how severe.

Your steel foundry can give you any property of steel, or any combination of properties, the end use makes desirable. And generally at a considerable saving in time, labor and cost, as compared with any other method of achieving results with steel.

Tell your steel foundryman what you need—for today's production *and* tomorrow's. Or consult Steel Founders' Society, 920 Midland Bldg., Cleveland, O. There will be no obligation involved in getting the facts.

MODERNIZE AND IMPROVE YOUR PRODUCT WITH

STEEL CASTINGS

Tools Are W

for today an

. . . Weapons that are winning the War and preparing for Peace. Among the vast array of weapons on the production front is one tool that today stands head and shoulders above the rest. It is the Lapointe modern broach. A tool designed for higher production, greater precision and longer life and so carefully designed that within its length and breadth innumerable cutting actions, all within exact tolerances, are possible. A tool which has no competitor in the metal removing field for internal and external shaping of continuous contours.

Broaching, in this array of weapons on the production front, is removing more metal faster, quicker and with greater precision on guns, tanks, planes and numerous other armament requirements. Broaching today is pointing a finger to the future — greater production, greater precision, better consumer goods and greater industrial development.

The SAE-80 Spline Broach used in the HP-150 Hydraulic Broaching Machine with Automatic Indexing Head for the complete broaching of hard steel propeller hubs. This work requires 2 passes of these large broaches and the machine is fully automatic cycling.

The LAPOINTE

reWeapons!

lay and tomorrow . .

The Lapointe Double Ram Surface Broaching Machine set-up for working vital airplane parts two at a time with three separate automatic cutting actions. Rate of production on this machine is 30 parts an hour.

Machine Tool Company ★ ★

HUDSON • MASSACHUSETTS • U. S. A.

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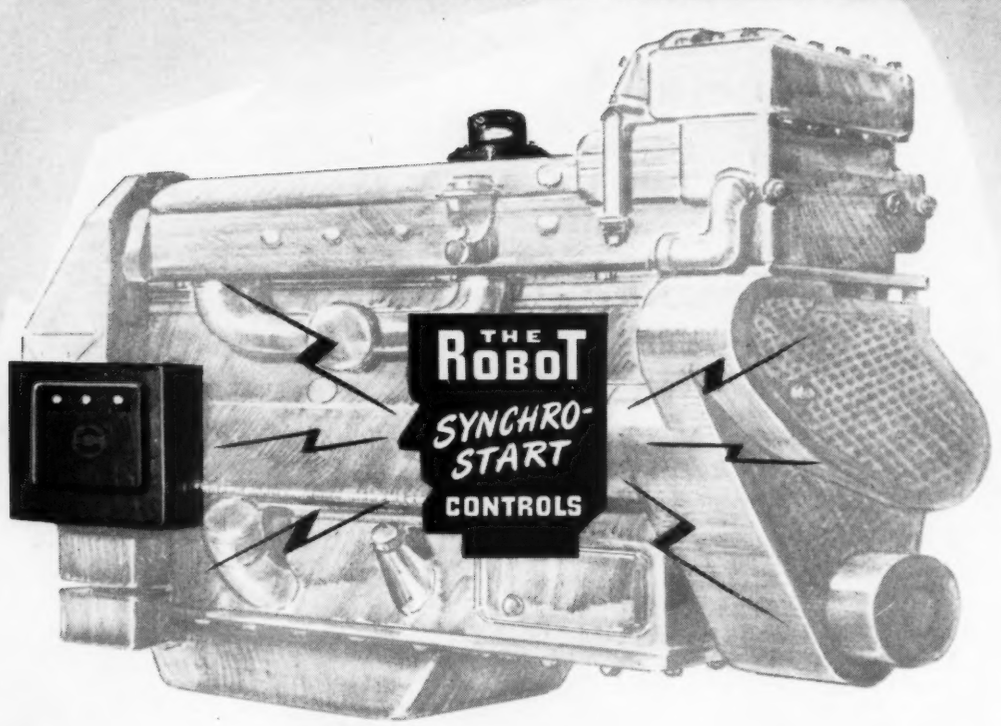
Gas, Gasoline, and Diesel Engines...

TODAY'S BEST POWER SOURCE



● During the past 10 years, internal combustion engines and SYNCHRO-START CONTROLS have been successfully replacing old fashioned methods of power generation and transmission, to provide a more dependable source of flexible, instantaneous, economical, automatic power. Such engines are today's best power source.

● As exclusive manufacturers of these Automatic Controls for internal combustion engines and as specialists in their adaptation to any power problem, we offer the experience of our engineers to both equipment manufacturers and power users, or,—better yet,—consult your engine manufacturer for complete information.

SYNCHRO-START PRODUCTS, INC.

221 EAST CULLERTON ST. **CHICAGO, ILLINOIS**

SYNCHRO-START *AUTOMATIC ENGINE* **CONTROLS**

NOT all of the weapons for waging this highly mechanized war are on the fighting fronts. Thousands upon thousands of them are winning a production war in America's industrial plants . . . 24 hours a day . . . seven days a week.

Such production calls for "weapons" of extreme flexibility in use and construction to withstand the continuous grind.

Outstanding among such "weapons" are the products of this company . . . American Flexible Metal Hose and Tubing . . . products which serve in almost every major industry.

And by "Flexible" we mean just that. Flexible in use, flexible in construction and serviceable for a thousand duties. There's no substitute for metal in its ability to convey oil, steam, hot water, gas, solvents, chips, dust, etc. . . . Other materials will perform *some* of these duties . . . other materials *are* flexible. But metal alone has the strength for endurance, the characteristics to withstand heat and cold, abrasion and vibration. Its Flexibility . . because of American's construction methods . . . is available in any degree required for the duty to be performed and, in the case of Seamless, there are records of many millions of flexings, without breaking.

Shown in the top illustration is American "Seamless", the bronze tubing without welds, joints, laps, seams or packing . . . as leakproof as the rigid seamless tube from which it is corrugated. Its resistance to pressure is increased by an armor of one or more wire braids.

American Interlocked hose, also pictured, is asbestos packed for heavy duty and severe service . . . bronze for steam and steel for oil. Also in light weight and unpacked for air, gases and light dry materials.

When the changeover to peacetime production takes place, you will find American products on the production lines in every conceivable use. Plan now . . . ask for descriptive bulletins on "Seamless" or any other type of flexible hose or tubing with American's dependable metal construction.

ANACONDA
from mine to consumer

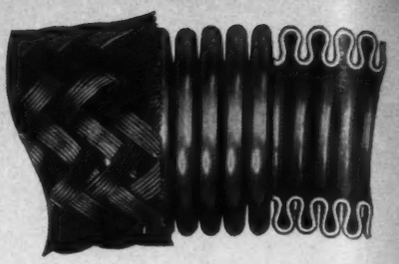
AMERICAN METAL HOSE BRANCH of THE AMERICAN BRASS COMPANY

General Offices: Waterbury, Conn. • • Subsidiary of Anaconda Copper Mining Company

In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

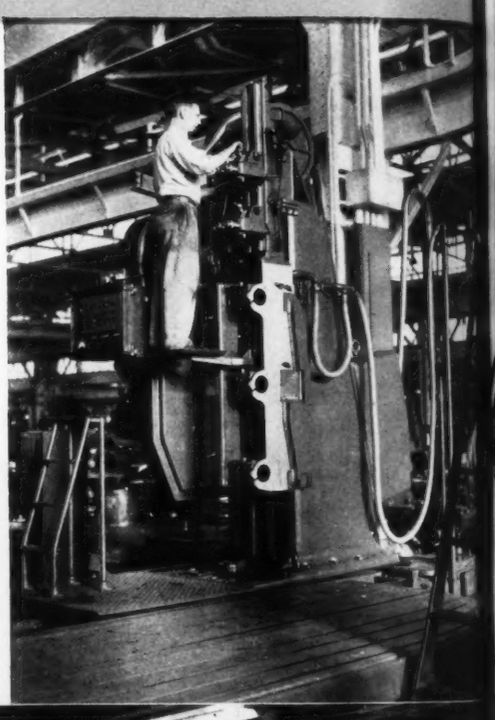
DEPENDABLE ACTION

BECAUSE IT'S *Flexible*



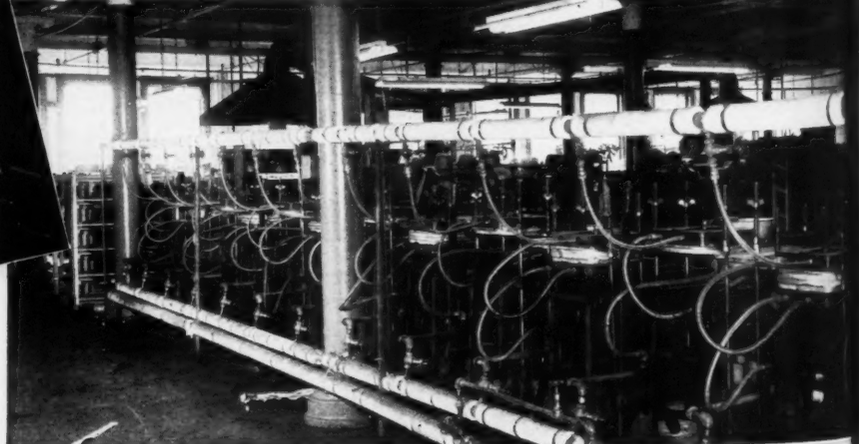
Above: American Seamless Flexible Metal Tubing—Br
Below: American Interlocked Flexible Metal Hose—

For conveying air, water, oil, steam or fuel where flexibility is required, there is *nothing* more dependable than flexible metal hose and tubing. Illustrated here are some typical installations of American Seamless—a few of a seemingly endless range of applications. Using almost any workable metal, we can build a flexible hose or tubing from a simple spout to a high pressure seamless hydraulic line. Whether you need a flexible connector for misaligned or moving parts, for isolating vibration, or for conveying fluids, you'll likely find we have a flexible metal hose or tubing that will do the job dependably and economically.



Protecting the electric power and control cables from chips, oil and grease is the job of this Flexible Metal Hose conduit on this huge, but precision-built, Keller Machine Tool.

Photo Courtesy of Pratt & Whitney, Division of Niles-Bement-Pond Co.



Above: American Oil Feed and Coolant Tubing lubricates the work on machine tools.
Right: Live steam being fed through American Seamless to hat forming presses.

4318

American Metal Hose

ANACONDA
from mine to consumer

AMERICAN METAL HOSE BRANCH of THE AMERICAN BRASS COMPANY
General Offices: Waterbury, Conn. • • Subsidiary of Anaconda Copper Mining Company
In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

Jacobsen Engines

LIGHTWEIGHT, DEPENDABLE POWER for Your Postwar Products

If you are interested in a new, advanced, self-contained power unit, 1/2 to 5 hp., for postwar equipment, let us tell you about the Jacobsen Engine. It is now being used exclusively for war and we cannot publish its specifications and design features.

Co-operation in Your Equipment Design Problems

A discussion of our engine and your requirements may contribute measurably to your design problem. The engineering and manufacturing facilities of the Jacobsen Manufacturing Company represent 21 years of experience in designing and building highly successful power units and related equipment. Frequently we have designed and manufactured special engines to meet the needs of original equipment manufacturers.

Write us at your convenience. State as fully as possible what your requirements are. We will reply promptly and frankly, and if you wish, make arrangements for a personal interview.

Jacobsen
MANUFACTURING CO.

781 WASHINGTON AVENUE . . RACINE, WISCONSIN

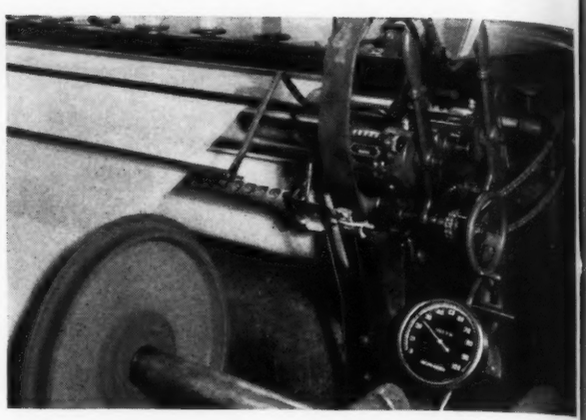
Efficient Production for Victory Demands Continuous Control of Every Machine!

...YOU CAN BE SURE WITH

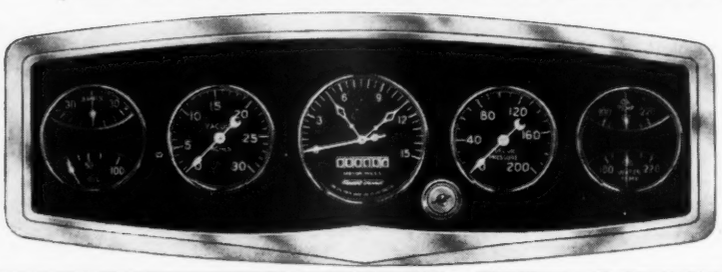
STEWART-WARNER

INSTRUMENTS!

Right now it's vitally important to know that every machine is doing its best *all the time.* Stewart-Warner Industrial Tachometers supply an accurate index to every machine's production by showing, at a glance, any production rate which is in proportion to shaft rotation. Whether you're filling bottles or making cloth, printing books or wrapping loaves of bread, these instruments give you continuous production control!



Electrical and Mechanical Gauges for Every Need!



COMPLETE INSTRUMENT PANELS

Where many kinds of information must be instantly available, Stewart-Warner Instrument Panels meet every requirement. They are offered in a variety of shapes and sizes, with instrument selection optional. All have indirect lighting, easily read dials, and conform to world-famous Stewart-Warner standards of accuracy.

All electric instrument panel includes tachometer, ammeter, oil and temperature gauges. Fits 6" opening. Size: 7" long by 6¼" high.

Electric tachometer for wood or metal instrument board. Size: 4 5/16" diameter. No battery or line current required. Face reading optional.

Magnetic tachometer has jewel-supported pointer staffs; pre-aged magnets; temperature compensators. Size: 2 11/16" or 4½" dia.

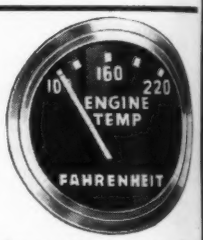
Ammeter for front mounting. Readings: 15-15, 20-20, 30-30, 50-50, 60-60, or 100-100. Volt meters, same type, 6, 12, or 24-volt.

Mechanical oil and air pressure gauges have precision mechanism. Ranges: 0-15 to 0-400. Front mounting. Sizes for 2", 2 19/32" or 3 29/32" hole.

Mechanical temperature gauge, accurate and dependable. Std. range 100-215 or 100-325. Sizes for 2 inch, 2 19/32" or 3 29/32" hole.

ELECTRIC TEMPERATURE GAUGE

Operates on magnetic principle, indicates 100° to 220° F.; other ranges available; white markings on black dial. Installation consists of screwing sending unit into half-inch pipe tap hole in engine water jacket, found on practically all industrial engines.



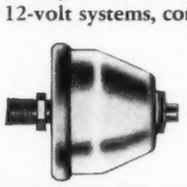
Electric Temperature Gauge Receiving Unit 100° to 220° F. For 6 or 12-volt D.C. systems. Other ranges available.

Electric Temperature Gauge Sending Unit 100° to 220° F. For 6 or 12-volt D.C. systems. Other ranges available.

ELECTRIC OIL PRESSURE GAUGE

Consists of a 6 v. receiving unit and a sending unit. This receiving unit indicates 0-80 pounds pressure; other ranges available; white markings on black dial. For 12-volt systems, connect Resistor 102095 to receiving unit terminal.

Oil Pressure Gauge Receiving Unit 0-80 lbs. For 6-volt D.C. systems. Other ranges available.



Oil Gauge Sending Unit 0-80 lbs. Has ⅛" P.T. connection. For 6-volt D.C. systems. Other ranges available.

Write for latest FREE Industrial Instrument Catalog!

Another Product of STEWART WARNER

STEWART-WARNER

1808 Diversey Parkway **Chicago, Illinois**

Here is a typical example of the methods "National" has devised to save time, materials, man power and machines.

Formerly, instrument screws were made milled from bar, with cut threads. They are precision parts, full machine finished, with class 3 threads, a closer tolerance than that of commercial screws.

"National" developed a method of manufacture from wire of smaller diameter . . . upsetting the head, machining the blank on noncritical equipment and rolling the thread.

This effected a saving of 61 per cent in stainless steel containing highly critical chrome and nickel, and released a large number of automatic screw machines vitally needed for other purposes.

More than 55 instrument manufacturers have been highly satisfied with the quality of these screws and the savings effected.

This booklet contains 15 brief stories of important savings on bolts, nuts and special parts. Send for a copy of "SAVINGS."

National
HEADED AND THREADED PRODUCTS

THE NATIONAL SCREW & MFG. CO., CLEVELAND, O.

Our troops use

landing barges

which

STANDARD forgings

help to

build

Whether for battleship or submarine, gun mount or tank, locomotive or industrial equipment, all Standard steel forgings and castings being used directly or indirectly in the war effort have a vital something in common. That something is the same high quality for which Standard products have been known in peace and war since the early beginnings of the company 148 years ago.

It is the kind of quality which Standard obtains by first producing acid open-hearth steel and then keeping every manufacturing process under rigid control right through to the finished forging. The Baldwin Locomotive Works, Standard Steel Works Division, Burnham, Pa., U. S. A.

BLW THE BALDWIN GROUP

BALDWIN

STANDARD

STEEL FORGINGS & CASTINGS

FORGINGS • CASTINGS • WELDLESS RINGS • STEEL WHEELS

"Not one penny for repairs"

The operating executives in some of America's largest corporations have been reporting on the performance of their Cleveland Worm Gear Speed Reducers—some installed as early as 1920.

On the vital subject of repairs, 8 of them have made these amazing statements:—

"*More than 20 years* with not a nickel's worth of repairs".

"*Clevelands installed in 1925*—never have needed attention".

"*12 years—300 days a year*—still running like new".

"*Every hour of the year;* no attention except to check lubrication".

"*Over 15 years* without inspection. Clevelands give satisfaction every way".

"*Since 1929* on our conveyors. No replacements. We selected Clevelands on account of their good record in our other plants".

"*Over 10 years* and no parts failure. Four of our plants have bought more than 200 of your Units".

"*Our first Clevelands installed in 1924,* still going strong; vital to our continuous operations".

Designed, built and installed years ago, thousands of Cleveland Drives are helping to carry today's burden of war production with never an hour of shutdown time—never a cent for parts replacement.

Clevelands on the equipment *you* build will serve just as faithfully through all the critical years to come.

Write "Cleveland" into your specifications—send for the Cleveland Representative now.

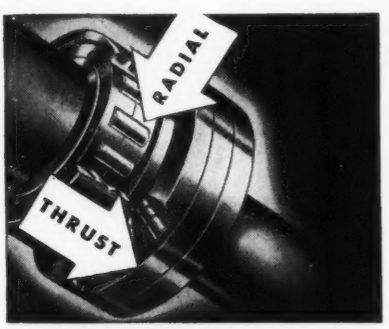
THE CLEVELAND WORM & GEAR COMPANY
3279 East 80th Street • Cleveland 4, Ohio
Affiliate: The Farval Corporation, Centralized Systems of Lubrication.
In Canada: PEACOCK BROTHERS LIMITED

CLEVELAND WORM GEAR
SPEED REDUCERS

Maintenance *will be* DOUBLY IMPORTANT *after the war...*

Look into this RIGHT-ANGLE BEARING LOADING *now...*

The hours spent on maintenance, the production lost through repair shutdowns, bulk large in management thinking today. Tomorrow, when operating costs spell either competitive advantage or handicap, control of maintenance time and cost will be *doubly* important. That's why Rollway's Right-Angle Bearing Loading may be the decisive factor in your sales results.



No Compound Loads
No Oblique Loads

- **ALL thrust loads are carried at right angles to the roller axis.**
- **ALL radial loads are carried at right angles to the roller axis.**

Right-Angle Bearing Loading Cut Maintenance Time & Cost

When load magnitudes are large . . . when thrust forces are continuous, intermittent or reciprocal . . . Rollway's Right-Angle Bearing Loading definitely improves bearing life and reduces maintenance cost:

1. by splitting the load into its two simplest components of pure radial and pure thrust.

2. by carrying each of these components on separate bearing assemblies, thereby reducing the magnitude of load per bearing.

3. by eliminating all compound loads, all oblique loads and their resultants.

4. by using the full strength of a *complete roller assembly* to meet the stresses of thrust loads.

★ **DON'T WAIT** until the urgency of postwar reconversion and redesign are crowding you. Investigate Right-Angle Bearing Loading now. Send us sketches or drawings for free bearing analysis and recommendation today. Or ask for a Rollway catalog, showing hundreds of series in S.A.E., or American Standard metric dimensions and tolerances.

ROLLWAY BEARING COMPANY, INC., SYRACUSE, NEW YORK

BUILDING HEAVY-DUTY BEARINGS SINCE 1908 **BEARINGS**

LET'S SPIKE A NUT

. . . to prove a point!

DRIVE A SPIKE right through both nut and bolt, so the nut can't budge. Now vibrate the assembly just as it would vibrate in ordinary use.

HERE'S WHAT YOU GET

—the nut did not move, but the strain and vibration of metal on metal wore the other parts loose—dangerously loose. Wear by abrasion, and *bolt stretch* etc. *loosen every vibrating part.*

Now keep the spike in but add a strong Kantlink spring washer,—then vibrate it just as you did in the first test!

HERE'S WHAT YOU GET NOW

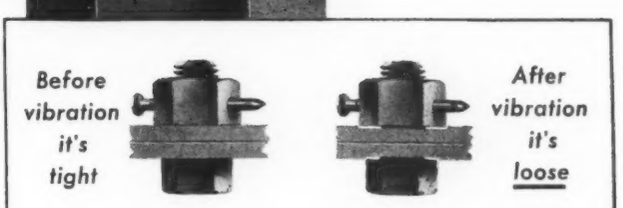
Yes, still tight, because the strong Kantlink spring reaction held it tight. The Kantlink Spring washer expanded exactly as fast (and as far) as the inevitable *wear tended* to loosen the parts.

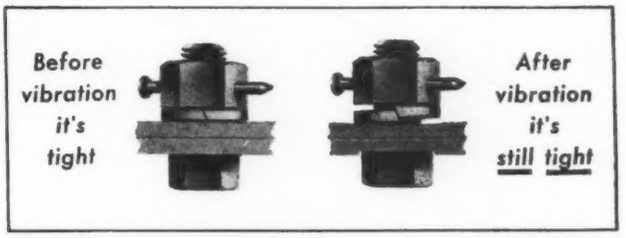
There is no substitute as economical. No fixed nut nor any short range multi-toothed washer can possibly equal the great holding power of a *wide-range live spring*—a big helical spring such as Kantlink.

Let us send you samples—send details of your application. Test and compare them on the same job with *any* type of nut, or with any other *type* of washer. Kantlinks can't lose a real test. Try them for efficiency, economy and real safety.

Write today for descriptive folder.

THE NATIONAL LOCK WASHER COMPANY
NEWARK, N. J., U. S. A.





KANTLINK
TRADE MARK

the long-range Spring Washer

No "softies", these "Unbrako" Self-Locking Hollow Set Screws! Mad tough at the start, they're hardened to "stand the gaff" and posses almost unbelievable strength, as proved by actual physical test What's more, they defy the menace of vibration and will not wor loose of their own accord. When tightened as usual, the knurls d *in and lock automatically.* Yet they can be readily removed with wrench and used over and over again any number of times. Avail able in all sizes from No. 4 to 1½" diameter. Remember the nam —be sure to specify "Unbrako" on your next order.

Knurling of Socket Screws originated with "Unbrako" years ago.

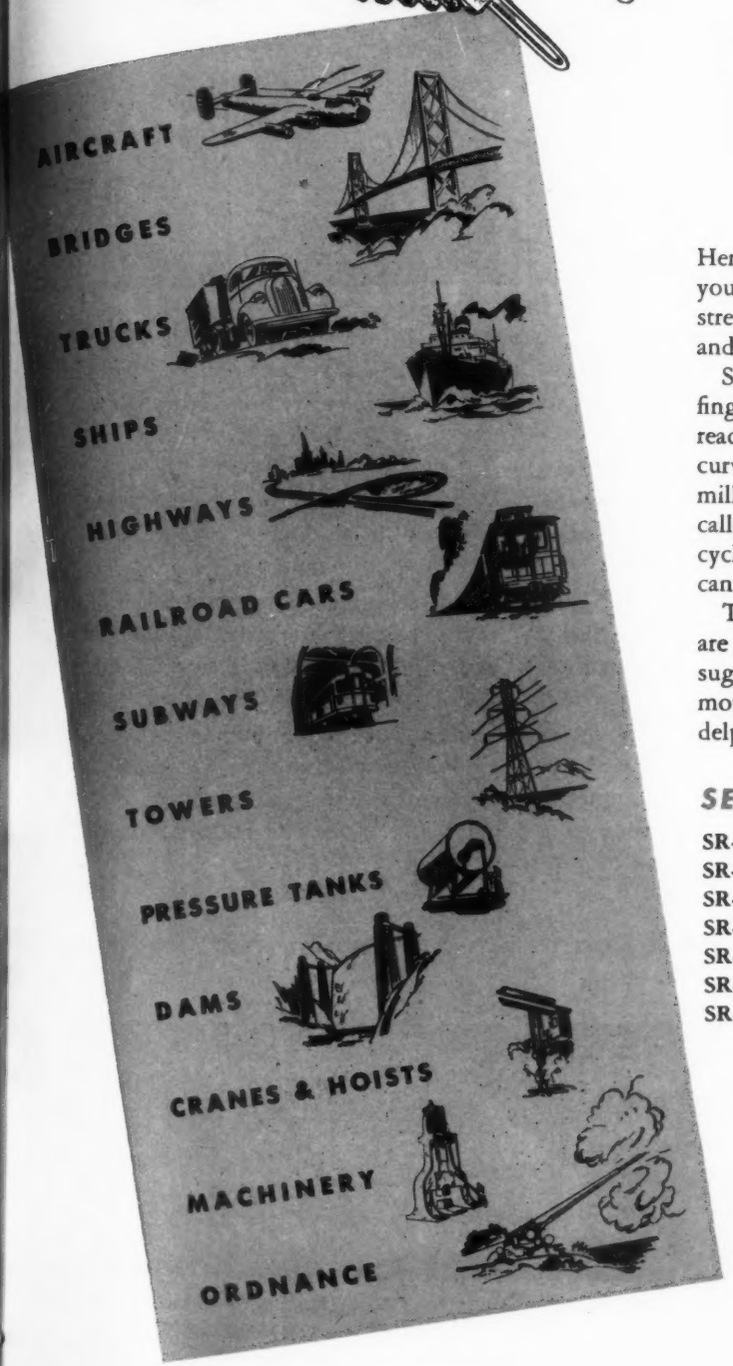
OVER 40 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA., BOX 545 • BRANCHES: BOSTON • DETROIT • INDIANAPOLIS • CHICAGO • ST. LOUIS • SAN FRANCISCO

SR-4 STRAIN GAGES

Answer "Will it take it?" Questions for You . . .



Here is the most simple, accurate and convenient device you can imagine for checking static or dynamic *design* stresses against *service* stresses in complex structures and machines.

Some types of SR-4 gages are as small as your little fingernail. They can be installed any place you can reach to cement them down on plane or moderately curved surfaces. They measure strains to one part in two million, statically, and to nearly as small a value dynamically. They respond without loss of linearity from zero cycles per sec to more than 30,000. Cost is low, so units can be installed in quantity in large structures.

The list shows some of the many fields where engineers are using SR-4 Strain Gages. Your own ingenuity will suggest where they can serve you. The Baldwin Locomotive Works, Baldwin Southwark Division, Philadelphia, Penna., U. S. A.

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THE BALDWIN GROUP

BALDWIN
SOUTHWARK
TESTING EQUIPMENT

TYPICAL PROBLEMS SOLVED BY SCOVILL COLD-FORGING "KNOW HOW"

Our business is *quality* special and standard cold-forged parts in quantity. Thus far this year we've shipped nearly a billion pieces—most of them war work—working in nearly all common metals.

Our stock-in-trade is unusual "know how" that makes cold-forging save money—metal—motions for our customers. Illustrated above are a few of the tough "specials" that show what we can do.

The same "know how" that makes us custom tailors in cold-forged parts also makes it possible for us to sell quality standard screw products at ordinary prices. Shown in the "S" are a few of our wide range of standard fastening devices.

It will pay you to talk over your present and postwar problems and needs with the nearest office listed below. Occasionally, our war commitments temporarily tax our capacity, but every inquiry receives a prompt, frank answer as to when and how we can be of service.

•

To the Reader: ***Kindly route this on to others to whom our "know how" can be helpful.***

SCOVILL MANUFACTURING COMPANY

WATERVILLE SCREW PRODUCTS DIVISION

WATERVILLE 48, CONN. TEL. WATERBURY 3-3151

NEW YORK, Chrysler Building • DETROIT, 6432 Cass Avenue • CHICAGO, 1229 W. Washington Boulevard • PHILADELPHIA, 18 W. Chelten Avenue Building
PITTSBURGH, 2882 W. Liberty Ave. • SYRACUSE, Syracuse-Kemper Insurance Bldg. • LOS ANGELES, 2627 S. Soto St. • SAN FRANCISCO, 434 Brannan St.

WINNING ON THE PRODUCTION FRONT, TOO!

Meeting the needs for forgings for machine tools, tanks and the bridge of ships is now almost an accomplished fact. Accordingly, we will shortly have available flat die and upset forging capacity to serve the needs of other essential equipment builders.

If you are making high priority machinery and need rings, blanks, bars or other flat die forgings or upset forgings, we will be glad to quote on your requirements for scheduled production thirty days hence.

While only a few hammers will be available at this time, we desire to serve first those who most badly need flat die and upset forgings. Send blueprints for quotation and be sure to include priority information.

KROPP FORGE COMPANY

"World's Largest Job Forging Shop"

5301 W. Roosevelt Road
Chicago (50), Illinois

Engineering Representatives in Principal Cities

KROPP

standardizing Your Bolts!

Let R B & W engineers help you check your present bolt and nut specifications according to the simplification program suggested by OPA and other war agencies. Quite likely you can include more "standards," more "stock sizes" without loss of holding power... relieve catalog and stocking confusion. RB&W has helped many firms avoid production delays and the expense of many small orders. Write us.

futurizing

BOLT-SHAPED METAL PART

After the war, RB&W's Research and Experimental Shop, now devoted to problems of military equipment, will again be at your service. If your product's design includes a metal part with bolt-shaped characteristics, we can make it for you by upsetting at a fraction of machining cost. RB&W cold headers, working even to aircraft tolerances, have made tremendous savings possible for many firms... will be ready to assist your *post-war* designing.

EMPIRE BOLTS NUTS RIVETS

and Allied Fastening Products ... Since 1845

RB&W RUSSELL, BURDSALL & WARD BOLT & NUT COMPANY

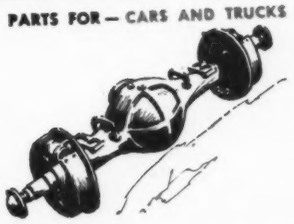
Factories at Port Chester, N. Y., Rock Falls, Ill., Coraopolis, Pa.
Sales offices at Philadelphia, Chicago, Detroit, Chattanooga, Los Angeles, Portland, Seattle

Making strong the things that make America strong

PARTS FOR — AIRCRAFT

Tail wheel assemblies, actuating cylinders and engine forgings. Brake lining. Camshaft and starter bearings.

PARTS FOR — CARS AND TRUCKS



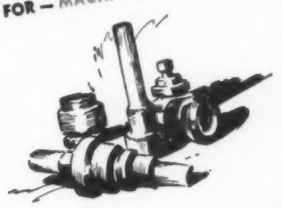
Automotive, industrial brake lining, axle, gear blank forgings, fan belts, clutch facings. Garage equipment.

PARTS FOR — TRAINS

Brake Shoes and Meehanite castings. Manganese steel parts. Journal bearings. Freight car wheels.

Are Parts A Problem? ...consider Brake Shoe as a Source

PARTS FOR — MACHINERY



Meehanite castings, upset and drop forgings, bearings. Manganese steel gears, sheaves. Pressure castings.

Brake Shoe **MAKES PARTS** for original equipment and for maintenance; parts that are upset and drop forged; molded fabrics and plastics; ferrous and non-ferrous castings. In war, as in peace, Brake Shoe ships millions of parts to thousands of manufacturers, in many fields of industry.

Whether your "punished part" problem requires one casting or thousands of steel forgings, Brake Shoe is equipped to help you.

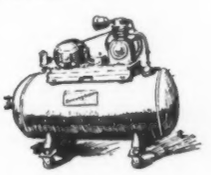
AMERICAN BRAKE SHOE COMPANY, 230 PARK AVENUE, NEW YORK 17, N.Y.

AMERICAN **Brake Shoe** COMPANY

59 PLANTS SERVING INDUSTRY AND TRANSPORTATION

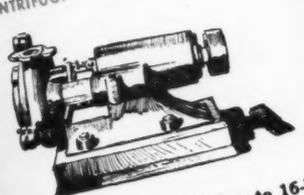
American Brakeblok Division	Detroit, Mich.
Ramapo Ajax Division	New York, N. Y.
American Manganese Steel Division	Chicago Heights, Ill.
Brake Shoe and Castings Division	New York, N. Y.
Kellogg Division	Rochester, N. Y.
American Forge Division	Chicago, Ill.
Southern Wheel Division	New York, N. Y.
National Bearing Metals Corp.	St. Louis, Mo.

AIR COMPRESSORS



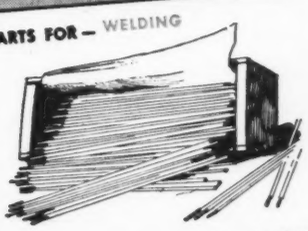
Cushioned air compressors, single stage and two stage, ranging in size from ¼ h.p. to 15 h.p.

CENTRIFUGAL PUMPS



Horizontal and vertical sizes to 16-in. discharge for handling all abrasive and corrosive liquids or materials.

PARTS FOR — WELDING



Welding rod, alloy steel for hard surfacing, non-ferrous rod for bearing surfaces. Nickel-manganese filler.

PARTS FOR — EXCAVATING

Placer dredge buckets, power shovel dippers. Quarrying, mining equipment parts. Bronze bearings.

GRAVE DIGGERS!

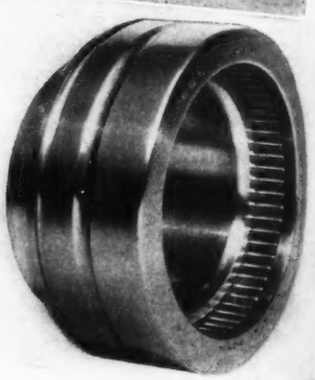
OSGOOD Excavating Machinery

equipped with

RBC

NEEDLE BEARINGS

Whether a bomb crater on the battle front or a military or industrial excavation job on the home front, both are graves for the eventual and, we hope, permanent interment of Axis aggression and oppression. Dig a little deeper, boys!



Heavy contributors to this cause are these Osgood units whose heavy pay loads are measured in millions of yards. To ease the way for operators and maintenance men, RBC CYCLOPS Needle Type Bearings are used on the double sprockets at the boom end and retract clutch gear of both Osgood types 70 and 80 when equipped for shovel service. They are also used on the reversing shaft on types 20, 70 and 80 irrespective of front end equipment.

Such heavy duty demands the high load carrying capacity of RBC Bearings with solid inner and outer races as well as full complements of rollers manufactured of high carbon alloy bearing steel.

ROLLER BEARING CO. of AMERICA

TRENTON . . . . NEW JERSEY

Can your product use the Pressurized Power in this Plane?

★ Have you ever watched a bomber fold its giant landing wheels into its wings?

The pressurized power that does this job is what we want to sell you. It is a hydraulic power system of entirely new efficiency and dependability . . . engineered for aircraft, available for all industry.

As a result of PESCO's more than ten years' specialization in making aviation pumps and related accessories, you will be able to equip your plant or product with a radically improved pumping system. For instance, you can have a compact, precision pump that delivers pressures up to 3000 pounds per square inch. This pump, weighing less than 4 pounds, forms the heart of a PESCO pressurized power system with endless uses in industry for transmitting or controlling power.

In addition to hydraulic pumps, PESCO builds pneumatic, vacuum and fuel pumps of equally high efficiencies, meeting practically all needs for pressurized power or controlled liquid flow.

The performance of PESCO equipment in your plant or product . . . its greater efficiency, dependability, and longer years of service . . . is assured by the fact that it has been engineered to operate under flying conditions which are far more extreme and demanding than any encountered down on earth. Won't you let us tell you more about PESCO Pumps and PESCO Engineering Service?

SEND FOR THIS BOOK "Pressurized Power and Controlled Flow by PESCO". This book pictorially tells the story of PESCO equipment, manufacturing facilities and engineering service. A copy will be mailed promptly upon request.

WRITE TO . . .
PESCO Products Co.
Industry Service M
11610 Euclid Avenue
Cleveland 6, Ohio

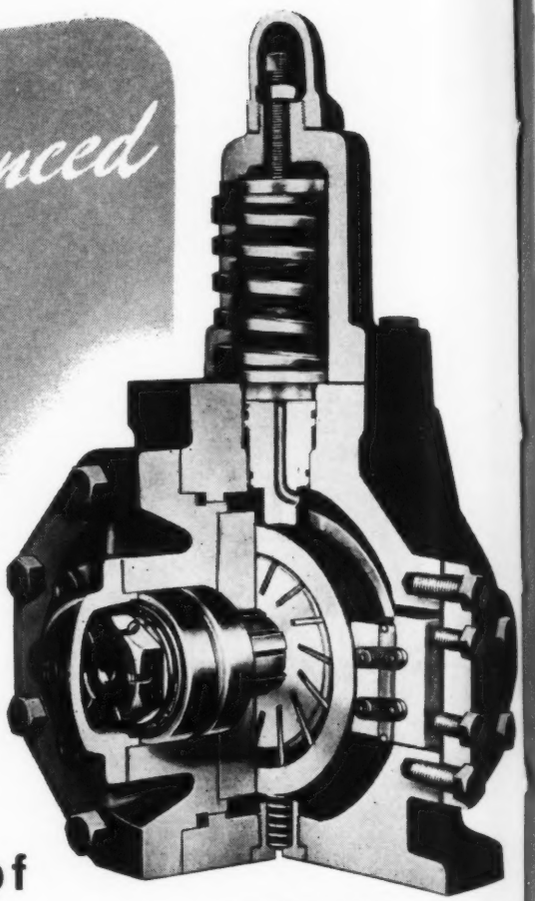
Division Borg-Warner

In Precision Hydraulics, Fuel Pumps, Air Pumps, Related Accessories . . .
PERFORMANCE POINTS TO Pesco FIRST

Hydraulically balanced

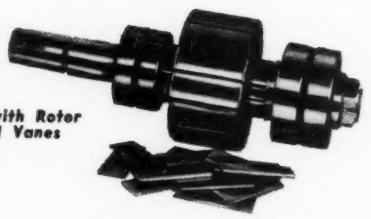
RACINE

VARIABLE VOLUME OIL HYDRAULIC PUMPS



Gives smooth non-pulsating flow of oil in modern hydraulic circuits

Special Alloy Port Plate



Shaft Assembly with Rotor and Alloy Steel Vanes

Precision grinding of Port Plate and interior parts in Racine Pumps allows closeworking fits with less possibility of seizing and scoring. Special Porting of bronze Port Plates hydraulically balances the Rotor Vanes and seals them against the Pressure Chamber Ring by centrifugal force. This exclusive feature of "non-forced" sealing eliminates pressure chamber wear, and increases pump life and efficiency. The fifteen hardened steel vanes give smooth non-pulsating flow of oil.

A Modern Source of Hydraulic Force

Racine Pumps and Valves are the heart of any modern hydraulic circuit. Any operation such as feeding, bending, molding or pressing can be efficiently performed with Racine Pumps. Write today for complete data and prices. Address your request to Dept. PE-P.

RACINE

oil hydraulic valves

Exclusive "Balanced-Piston" "Sleeve Type" construction for smooth oil-cushioned control of hydraulic circuits. All interior working parts are hydraulically balanced. Piston lands are grooved to minimize hydraulic set. Available in a wide range of portings with various control devices—sizes ⅜" to 1½".

Racine Hydraulic Metal Cutting Machines

The Production Saws of Modern Industry

For general purpose or production metal cutting. Racine Saws include the latest operation and control devices for fast and efficient metal sawing. Capacities are 6" x6" to 20" x 20".

STANDARD FOR QUALITY AND PRECISION
RACINE
RACINE TOOL and MACHINE CO.

RACINE TOOL and MACHINE COMPANY

Standard for Quality and Precision

RACINE • WISCONSIN • U. S. A.

Something Worth Looking For

Something much more important than natural or synthetic rubbers and fabrics is woven into every Dayton V-Belt. You might call it Technical Excellence. Or you might more accurately call it the heartaches and achievements of Chemical and Research Technicians who during 37 years have patiently devoted *millions of man-hours* of sweat and labor to continuous rubber and fabric research and development.

For example, in *one* year the men of Dayton Rubber have devoted more than 166,000 man-hours to V-Belt research and development. In addition during the same period, they have made over 1,000 separate laboratory tests and some 1,200 field tests.

Product of all this is a V-Belt built upon the enduring and constantly fortified foundation of priceless experience in the processing and application of all available (or likely to be available) combinations of natural or synthetic rubbers and fabrics. It bears the name Dayton Rubber. It is a name worth looking for.

THE DAYTON RUBBER MFG. CO.
DAYTON 1, OHIO

KEEP ON BUYING WAR BONDS

V-Belts by Dayton Rubber

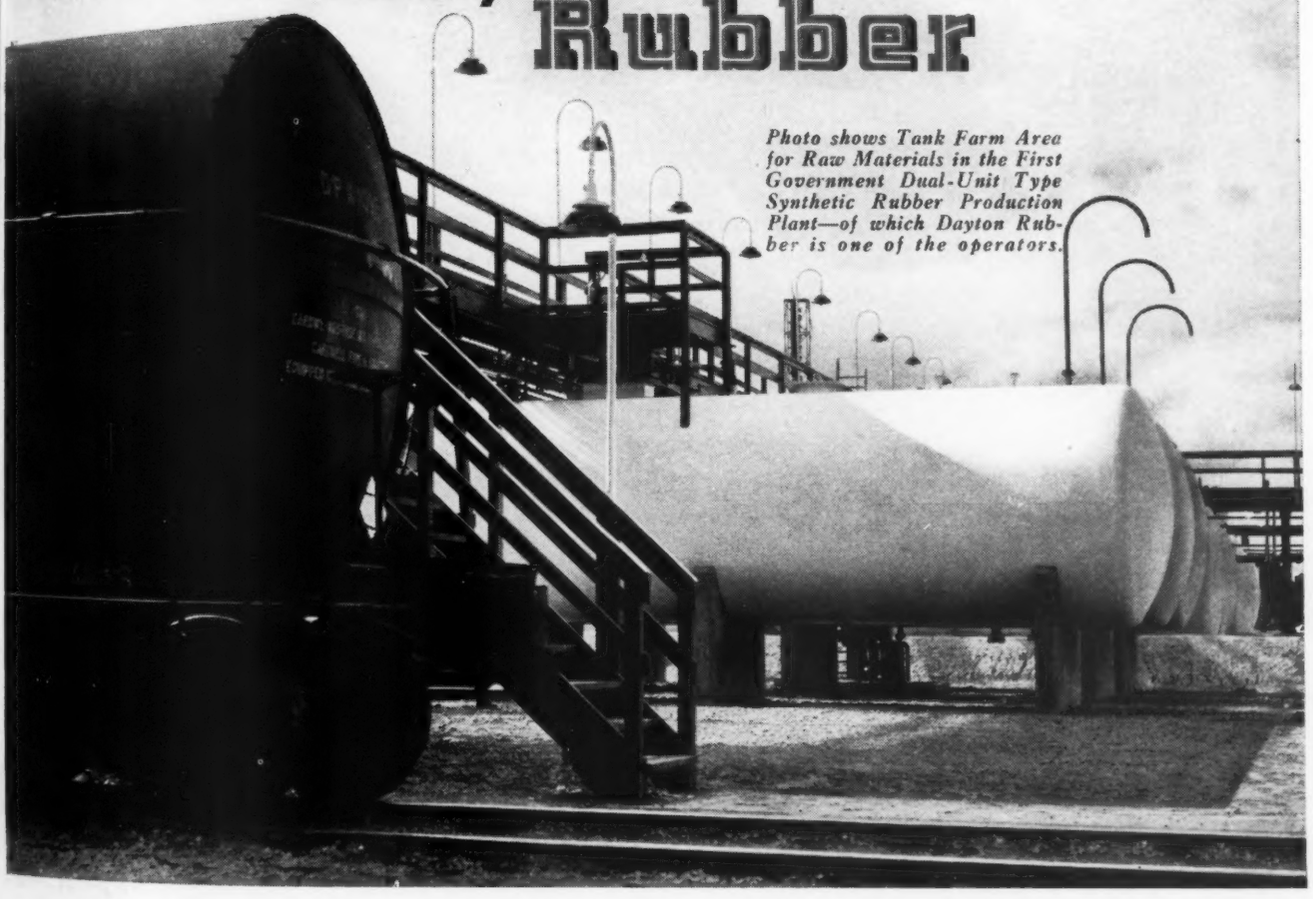


Photo shows Tank Farm Area for Raw Materials in the First Government Dual-Unit Type Synthetic Rubber Production Plant—of which Dayton Rubber is one of the operators.

The portable extinguisher 80 feet long!

No, not the container...that's a handy unit only 7 inches in diameter by 27½ inches high. But the carbon dioxide it contains, stored under high pressure, expands 450 times in volume when it's released. That's enough of the fire-smothering gas to fill a cylinder 80 feet long by 2 feet in diameter! And that's why this Kidde product is one of the fastest fire-fighters known.

Walter Kidde & Company has prepared a booklet, "How to Teach Fire Fighting." It describes the various classes of fire, tells how to fight each of them. It explains why the most modern extinguisher can actually be a dangerous fire hazard, if it's used against the wrong fire! Write for your copy—it's free.

WALTER KIDDE & COMPANY, INC., 1244 MAIN STREET, BELLEVILLE, N. J.

Norma-Hoffmann Precision Bearings Help Supply

"THE BREATH of LIFE" for ENGINES AT SUB-STRATOSPHERE HEIGHTS

What his oxygen supply is to the high-altitude flyer, the supercharger is to his engine. Failure of either is fatal. Together, they make possible the high-altitude fighter planes and bombers that are playing so conspicuous a part in today's warfare.

In the use of anti-friction bearings in superchargers, as in so many other aviation applications, NORMA-HOFFMANN pioneered the way. The terrific speeds of supercharger operation —often as high as 60,000 RPM—demand that ULTRA-PRECISION long characteristic of NORMA-HOFFMANN BEARINGS. And today, not only in superchargers but elsewhere at vital points throughout the plane, NORMA-HOFFMANN PRECISION BEARINGS are doing their part in winning air supremacy for the Allied Air Forces in every theatre of war.

"Where the bearings MUST NOT fail"—in engines, control mechanisms, instruments, armament, radio equipment and other aircraft accessories—they are providing that combination of speedability, load capacity and dependability so vital to the unfailing performance of the plane.

Let our engineers work with you.

"NORMA-HOFFMANN"

PRECISION BEARINGS

BALL, ROLLER AND THRUST

NORMA-HOFFMANN BEARINGS CORP'N, STAMFORD, CONN. . . . FOUNDED 1911

"Pioneer Suppliers for 20 Years of Ultra-Precision Bearings for Superchargers"

TO WIN THE WAR — *Work — Fight — Buy War Bonds!*

THE AUR

War Plants in 30 States Use Lyon's Sheet Metal Facilities

Over 2,400 Contracts for Production-Run Sheet Metal Fabrication Handled in This Company's Plants Since July, 1940

SINCE this 43-year-old sheet metal fabricating company made production of war materiels its major activity, it has helped many war plants meet or beat seemingly impossible production schedules. By drawing on Lyon's facilities for production-run sheet metal fabrication these plants were able, not only to secure and expedite vital war contracts, but to do this while saving their own manpower for other vital war jobs.

While Lyon Metal Products, Incorporated, has handled over 2,400 war contracts from 30 states, its capacity for helping large or small manufacturers meet production quotas has by no means been reached. Lyon has approximately 2,000 experienced factory workers. Complete facilities for all sheet metal jobs . . . as well as fabricating facilities on aluminum and chrome-moly steel include: (1) One half million square feet of manufacturing floor space; (2) Perforating, blanking, forming, assembling, drawing, annealing and lacquering equipment; (3) Complete toolrooms in all plants.

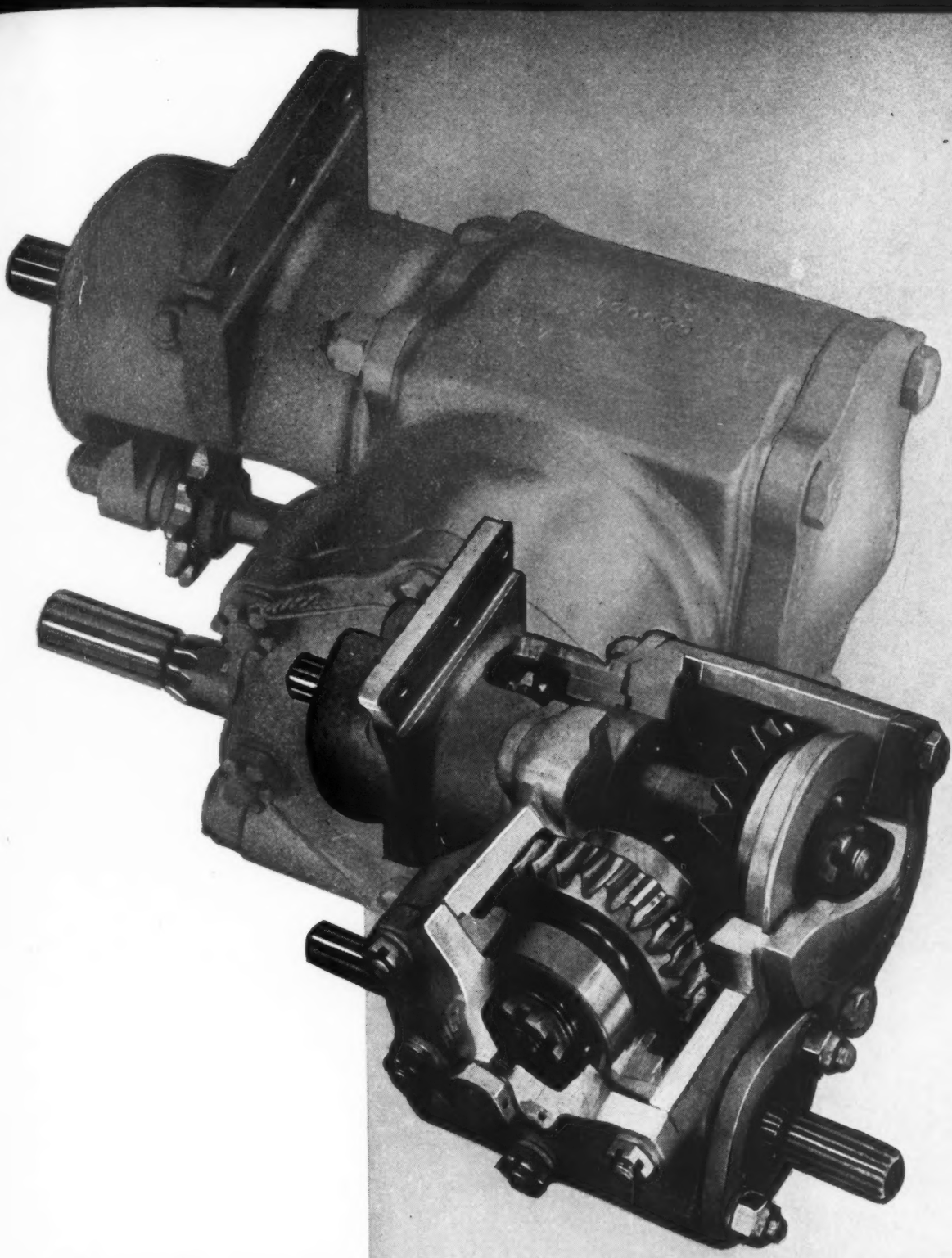
IF YOU HAVE A PRODUCTION-RUN SHEET METAL FABRICATING PROBLEM, LYON METAL PRODUCTS, INCORPORATED, HAS FACILITIES, MANPOWER, MANAGEMENT AND FINANCIAL RESOURCES THAT WILL HELP YOU SOLVE IT.

Write on business letterhead for new FREE BOOK —"Craftsmen in War Production"— describing LYON'S facilities for providing fast mass production of sheet metal products that will expedite your war contract and save your manpower for other vital work.

LYON METAL PRODUCTS, INCORPORATED

General Offices: 1282 Madison Avenue, Aurora, Illinois

Sales and District Offices Manned by Experienced Engineers in All Principal Cities



Flap Transmission for an Aerial Freighter

Due to our wide experience in the field of aircraft hydraulic actuators, one of the nation's leading aircraft builders called on us to design and build a mechanism to operate the wing flaps on one of their large cargo planes. These flaps are used for maneuvering and braking the plane during a landing and the control is extremely sensitive. A very special mechanism was needed, light, as there are fourteen of them in the wing, and strong enough to withstand unusually high torques.

VARD engineers developed this wing flap transmission. A row of these small gear boxes is linked together by splined shafts, running out of a central transmission in the fuselage. Flaps are extended or retracted by chain drives from the individual transmissions in line.

For years, VARD has built precision aircraft parts and gages, but few pieces of aircraft equipment which we have built top this small transmission for critical accuracy. Despite its small size, it handles an unusually high load through a forty-five to one gear reduction. The unit contains chain sprockets, a worm and a worm gear and zerol bevel gears, all carried on ball bearings. Tolerances are at a very minimum, as there can be no slack in the whole transmission system.

We designed and are building this transmission complete, making every part except nuts, bolts and ball bearings. It has been fully tested by the plane manufacturers and declared a good job.

VARD INC. PASADENA, CALIFORNIA

ARMY E NAVY

HYCON

HIGH PRESSURE HYDRAULIC SYSTEMS

Equipment Available for Immediate Delivery

Eight Cylinder Pump with Unloading and Relief Valve Mounted on 3 HP Motor to furnish 250 cu. in. per min. at 3000 p.s.i. Valves, Accumulators and Complete Line to provide flexible, economical installations

★ ★ ★

• CATALOG ON REQUEST •

THE NEW YORK AIR BRAKE COMPANY

Hydraulic Division

420 Lexington Avenue, New York 17, N. Y.

PROBLEMS THAT COME TO *Gilmer*

WILL A RUBBER BELT LAST WHEN EXPOSED TO OIL?

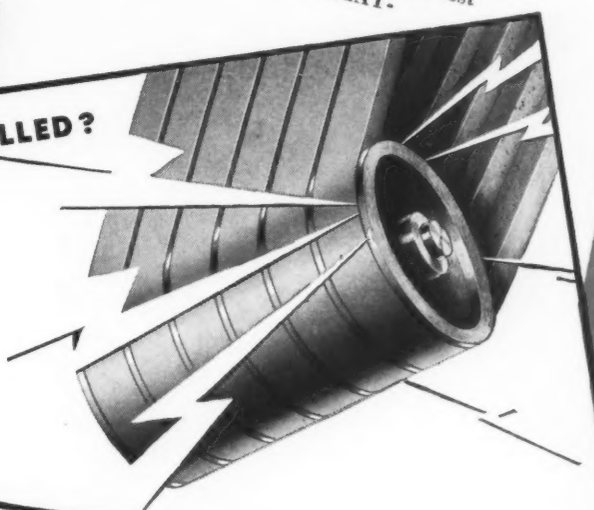
Under the present government program, most rubber products are being converted from crude rubber to synthetic rubber. *All* synthetic rubber is not oil-resistant. But, Gilmer engineers and chemists developed a synthetic oil-resistant compound and put it on the market 12 years ago. You can have any multiple V-belt, Flat belt, or Round belt with this special construction to combat excess oil conditions. Remember: GILMER OIL-RESISTANT BELTS.

CAN YOU RUN A RUBBER BELT IN HEAT THAT WOULD FRY AN EGG?

Most Gilmer Belts can be supplied in a special heat-resisting quality. These specialized products are built to run in temperatures up to 300°F., when such temperatures are intermittently present. The belts are designed to give life-time service in steady temperatures up to 200°F., or 75°F. above the temperature test of normal belting. Remember: GILMER HEAT-RESISTANT BELTS.

CAN STATIC DISCHARGE BE CONTROLLED?

The special static dissipating features developed by Gilmer engineers has been approved by Fire Underwriters and is available in any standard Gilmer Belt, with the exception of textile-woven Speedages. It drains static continuously through the pulleys and does away with the costly static dissipating devices. Remember: GILMER STATIC DISSIPATING BELTS.



WHAT ABOUT STRETCH CONTROL?

To prevent excessive stretch, Gilmer V-Belts are constructed with normalized cords . . . cords that have been worked to prevent subsequent shrink and stretch. This gentle "working" does not injure the strands of the cord, and in bringing the stretch under control, a certain elasticity is retained to prevent a brittle condition which would affect tensile strength. Remember: GILMER NORMALIZED CORDS.

GILMER ENGINEERING SERVICE

Whatever your design problem may be, remember that Gilmer's Design Engineers are at your service, ready to give you the benefit of their skill and knowledge. See Sweet's new File for Product Designers for handy condensed specifications or write for Gilmer's Belt Catalogues. Don't hesitate to ask for help on design problems.

Gilmer BELTS

Planer Belts • Special Endless Belts

L. H. GILMER COMPANY

Tacony, Philadelphia 35, Penna.

THE OLDEST FIRM OF RUBBER FABRIC BELT SPECIALISTS

V-Belts (F. H. P. & Multiple) • Flat Belts • Round Endless Belts • High Speed Belts • Fabric Belts

THE PART YOU CAN'T SEE . . .

Nine-tenths of that iceberg is under water . . . the most important part is the part you can't see.

A lot of important parts are those you can't see. Thousands of them are making America's war machinery invincible . . . thousands more will make peacetime machines and appliances efficient, easy to use, and long lasting. They are parts of rubber, synthetic and natural, and they are essential in war and peace.

War demands have taught engineers and designers at Johnson Rubber a lot about precision . . . many of our parts today must be accurate in a way never known to the rubber industry before . . . and exacting needs make specifications rubber an accomplished fact.

Thousands of such small parts make the efficient, unbeatable operation of America's war machines possible . . . all Johnson Rubber production today is for Uncle Sam.

There will come a day, though, when we all have to think about transferring the boys' names from the honor roll to the pay roll, and getting back to our regular job of supplying a peacetime market. To meet that great day with a minimum of time waste is important to the boys coming back . . . and important to you.

Lay your plans now. Let us help you. Johnson engineers and designers can help you solve problems in your post war products . . . and come up with the right answers in the right kind of rubber in the specific part you need . . . and this precision in rubber perfected in wartime will serve you well in peacetime.

We will be ready to supply you when the time comes . . . but the time to think about it and plan ahead is now . . . not then.

The JOHNSON RUBBER CO. • Middlefield, Ohio

MOLDED & EXTRUDED RUBBER PARTS FOR INDUSTRY'S VITAL ASSEMBLIES

Indispensable in War—Essential in Peace

Since 1895

to hold that line—

OILGEAR

In this welding positioner Oilgear Fluid Power solved 6 difficult design problems.

on a 50-ton steel shape or on a sheet of cellophane

THERE is a world of difference between holding the hairline register in printing flimsy cellophane and holding a line in the automatic welding of a 50-ton steel shape. But the fact that Oilgear Fluid Power has solved these and far more varied problems makes it seem certain *your* particular problem will yield to the versatility and flexibility of this proven power application system.

Here are just a few of the functions Oilgear Fluid Power will provide . . . steplessly and infinitely variable speed control of moving members . . . force *without* movement . . . a simple means of applying great power . . . the synchronizing of a number of motions . . . perfect sequence or cyclic operation.

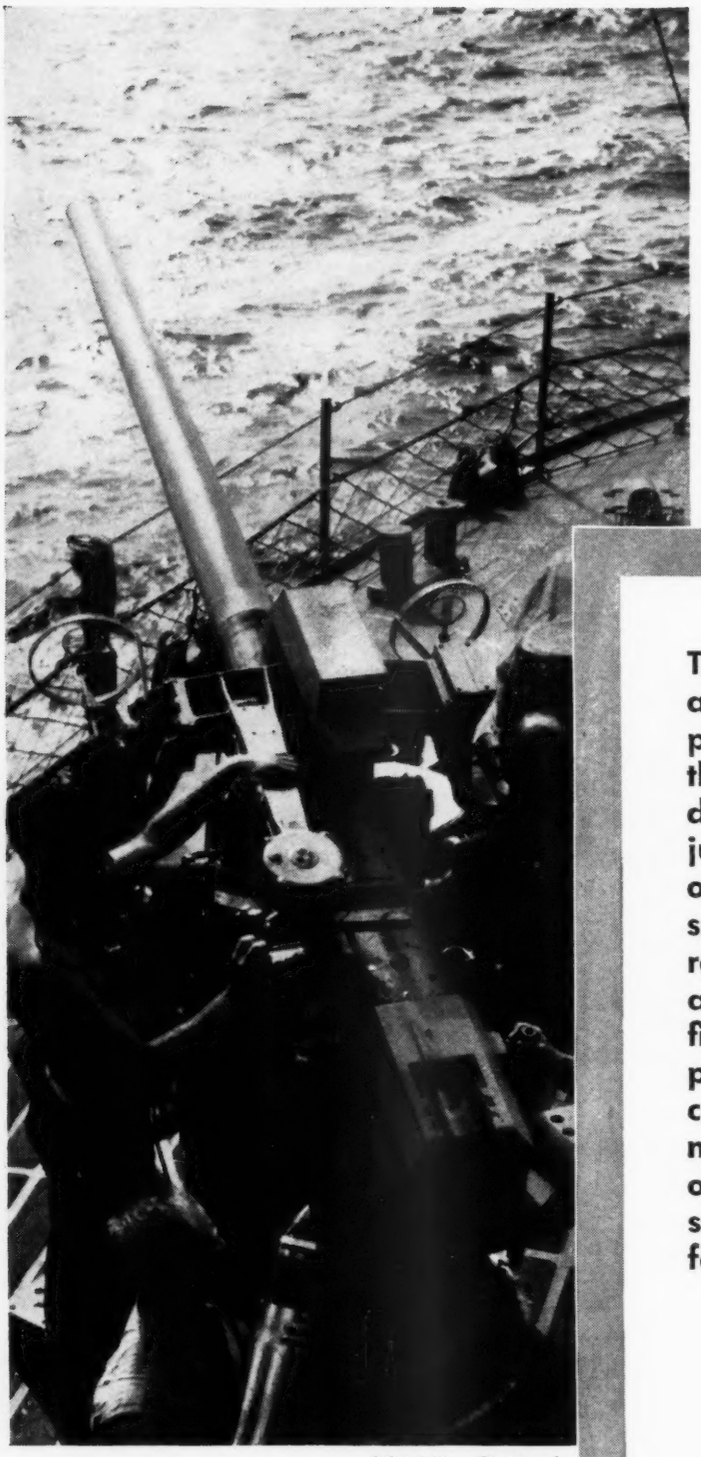
For a quarter of a century Oilgear Engineers have applied these and other Oilgear Fluid Power functions to hundreds of different machines and mechanisms in hundreds of different ways . . . with results which often have been amazing. Oilgear Engineering know-how and Oilgear Fluid Power adaptability may provide just the answer you are looking for in that machine you are going to bring out. Now is the time to see. The Oilgear Company, 1311 W. Bruce St., Milwaukee, Wis.

ARE YOU TRYING TO:

1. Apply large forces through long . . . or short . . . strokes at variable speeds?
2. Obtain automatic work cycles, variable speeds in either direction . . . with or without pre-set time dwell?
3. Apply large forces through continuous or intermittent reciprocating cycles at constant or variable velocities?
4. Obtain extremely accurate control of either position or speed of a reciprocating member?
5. Apply accurately variable pressure either static or in motion?
6. Closely synchronize various motions, operations or functions?
7. Apply light . . . or heavy . . . forces at extremely high velocities through either long or short distances of travel?
8. Obtain continuous automatic reversing drives at constant R P M or over a wide range of speed variation?
9. Obtain accurate remote control of speed and direction of rotation, rates of acceleration and/or deceleration?
10. Obtain constant horsepower output through all or part of a speed range?
11. Obtain automatic torque control?
12. Obtain accurately matched speed of various rotating elements?
13. Obtain constant speed output from a variable speed input?
14. Obtain full pre-set automatic control, elimination of problems of shock, vibration, etc.?

You Need Oilgear!

OILGEAR
Fluid Power



Official Navy Photograph

GEARS... GUNS... AND MEN!

Today's victories of our armed forces are the result of their superior fire power on land and sea . . . and in the air — a superiority attained by design engineers working in conjunction with the army and navy ordnance departments. Victory and success depend on gun calibre and range . . . also its maneuverability and the clock-like precision of the firing mechanisms. . . . D.O.James precision-made gears are important controlling factors in attaining the maximum fire power and efficiency of many of the guns now being so successfully used by our armed forces.

Accurately conforming to these design requirements has been an every-day "must" in our organization for over 55 years in the design, engineering and manufacture of all types of gears and gear speed reducers.

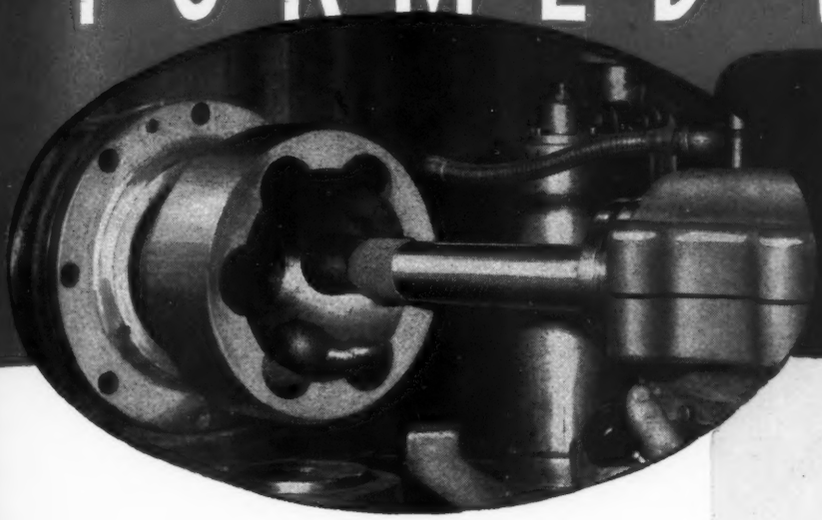
D.O.James

Established 1888

D.O.JAMES MANUFACTURING CO., 1140 W. MONROE STREET, CHICAGO, ILL.

FORMED WHEEL

Groove Grinder

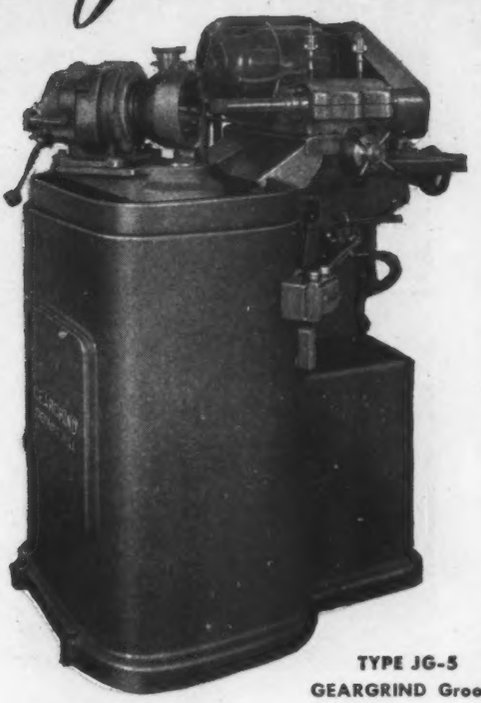


This special GEARGRIND Machine was designed for grinding the ball grooves in the outer housing of the RZEPPA Constant Velocity Universal Joint.

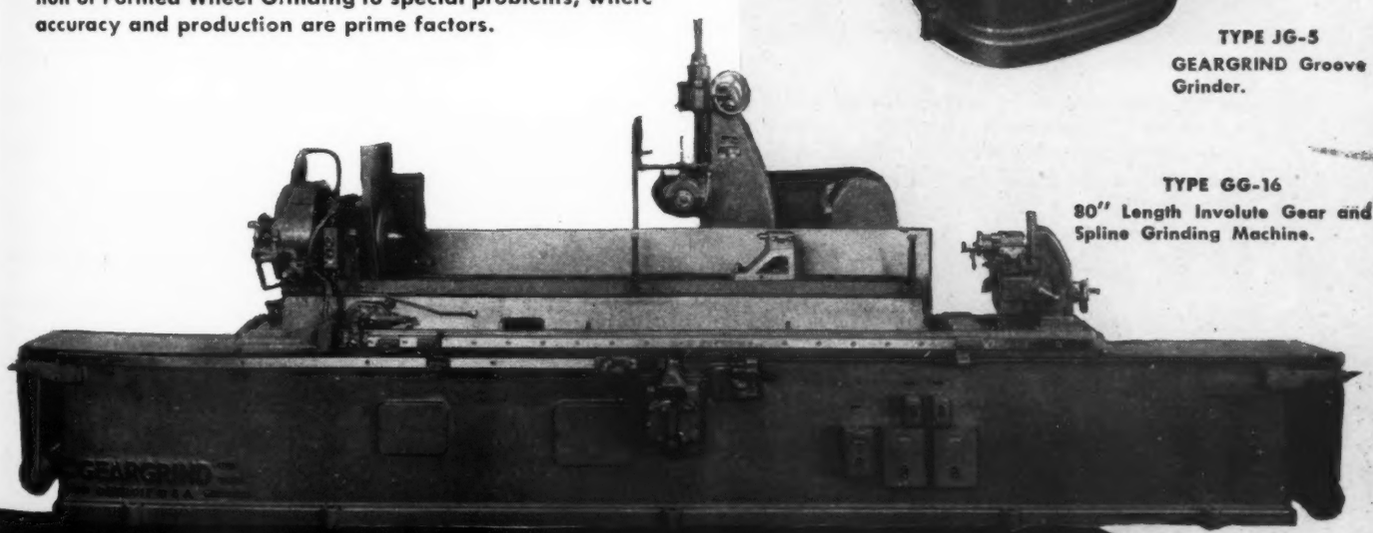
The work oscillates on a swinging head, controlled by an automatic magnetic brake, permitting the Formed Wheel to grind the radii for the ball groove in a curve. The formed grinding wheel is fed in from the front, the rapid traverse of the table being governed by means of an air cylinder. The spacing of the grooves is controlled by an accurate index head.

Ball grooves in the various sizes of Rzeppa joints range from $1\frac{1}{16}''$ to $1\frac{13}{16}''$ and this machine accommodates them all.

GEARGRIND engineers will be glad to discuss the application of Formed Wheel Grinding to special problems, where accuracy and production are prime factors.



TYPE JG-5
GEARGRIND Groove Grinder.



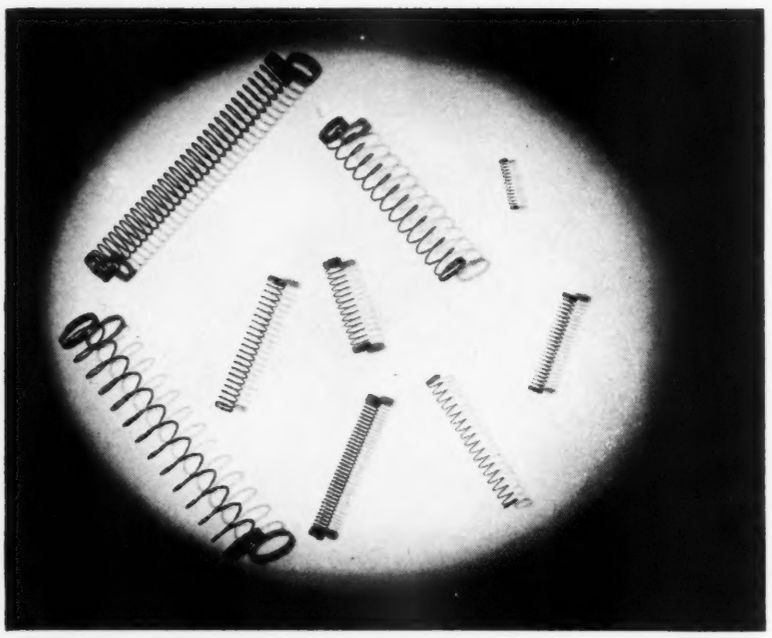
TYPE GG-16
80" Length Involute Gear and Spline Grinding Machine.

The GEAR GRINDING MACHINE COMPANY
DETROIT, MICH. U.S.A.

ARMY E NAVY

To the Seven Men in Eight who Never Need Anything but "Average" SPRINGS

As producers of over a million and a half beryllium copper coil and flat springs a week, we at Instrument Specialties are in an ideal spot to see how many "average" spring orders are filled before one "fancy" spring job comes through. We are also in the ideal spot to see how readily many springs which function under "average" conditions may be improved in their operating characteristics by "Micro-Processing" — an exclusive I-S process.



There is no premium on micro-processed beryllium copper brush springs which increase brush life 25% or more, because that is the only way we know how to make them. And, in the bargain, our production methods and material in stock assure quick delivery.

There is no "mumbo-jumbo" about micro-processing. We obtain closer tolerances, higher tensile strength, consistent uniformity, higher electrical properties, and minimum drift, with step-by-step precision control which begins with the wire or strip itself. So, we produce average springs by the same method that we use for fancy springs — and you benefit because micro-processing makes the most of the inherent qualities of beryllium copper, regardless of your service requirements.

A limited quantity of the "Bibliography of Beryllium Copper" is available. A note on your company letterhead will bring your copy by return mail.

The best way to prove the value of micro-processing is for us to show you performance on your own springs. Our sample department is set up for quick action. Send us springs, drawings or working specifications. Micro-processing does make a significant difference — even on average springs.

INSTRUMENT SPECIALTIES CO., INC.

DEPT. K, LITTLE FALLS, NEW JERSEY

Proved for you . .

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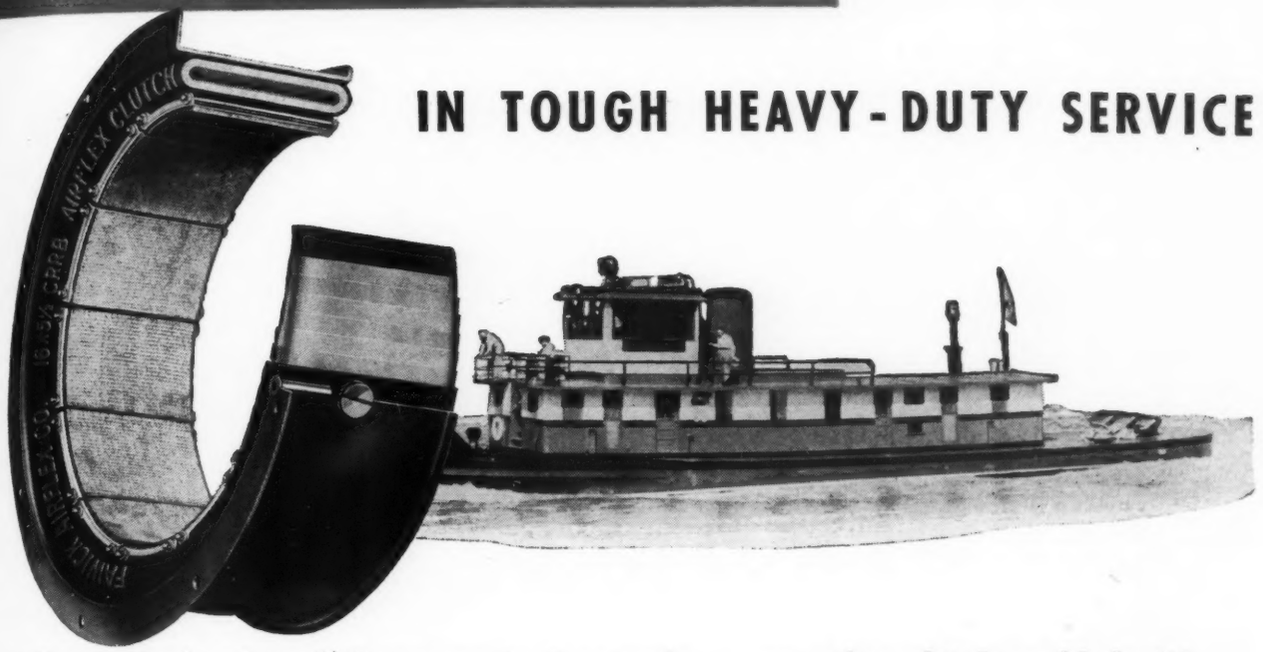

Full speed ahead to full reverse in 3 seconds . . . *no other clutch could do it!*

This tug—typical of hundreds of Navy and Merchant Marine vessels—is proving every day that the Fawick Airflex Clutch handles heavy service jobs with entirely new standards of efficiency and economy.

The Fawick Airflex Clutch protects both prime mover and driven member against shock, strain and vibration—through controlled air pressure.

No moving parts, no arms, levers or toggles, no lubrication required. Maintenance costs very low. Operates as clutch, brake, slip clutch or flexible coupling.

For any heavy-duty application—on any machine—send us details and we'll gladly recommend the Fawick Clutch or Brake that best fills the need.

FAWICK AIRFLEX COMPANY, INC.
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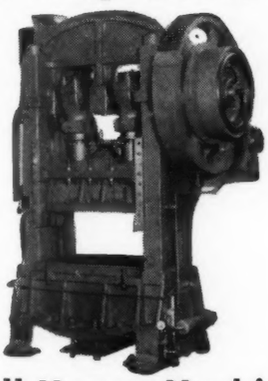
In Britain, **Crofts Engineers, Ltd., Bradford, England**



For All Heavy Machinery

On Punches, Shears, Turbines and severe-duty drives, Fawick Airflex Clutches and Brakes are compact, silent, smooth and shock-free. They slip readily under overloads and save on power.

12 IMPORTANT ADVANTAGES

1. Simple in design and operation.
2. Flexible control by air.
3. No adjustments or oiling—low maintenance.
4. Dampens vibration—absorbs shocks.
5. Corrects misalignment automatically.
6. Smooth starting—no jerks.
7. Runs cooler—uniform pressure.
8. Controls torque by air pressure.
9. Greater capacity—more compact.
10. Remote control by air valve.
11. Replaces couplings.
12. Acts as clutch, slip-clutch or brake.

FAWICK *Airflex* CLUTCH

POWER CONTROLLED BY AIR

DUST OFF your ideas on ELECTRONICS

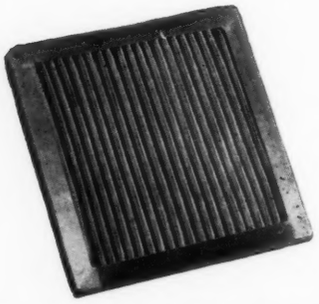
Usually it's not hard to figure out methods of cooling electronic devices. You can punch holes in the housing, install fans or even use water jackets.

Unfortunately, as dust settles on the equipment, less and less heat is radiated, and electrical contacts wear. Under these conditions, the performance of a good electronic idea comes to depend on how often and how well someone cleans it.

The remedy for this nagging problem of the electronic designers is to clean the air that cools their equipment. Air-Maze filters are especially designed for these applications.

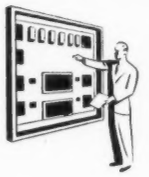
Compact, light and efficient, Air-Maze filters are cleanable and built to last as long as the equipment itself. They are unaffected by temperature or climatic conditions. They can be made in practically any size or shape, and to meet widely varying requirements.

Air-Maze engineers have specialized in air filter design for nearly 20 years. They will gladly help on your problems.



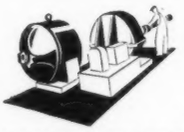
Air-Maze electronic equipment filters combine high dust arresting efficiency with extremely low resistance and compactness. Air-Maze engineers will be glad to make recommendations for particular problems.

A Few Places to Use Air-Maze Electronic Equipment Filters



RADIO TRANSMITTERS

ELECTRONIC WELDING



VOLTAGE REGULATORS

INDUCTION HEATING

Wherever electronic equipment requires ventilation, these Air-Maze filters can be designed and built to solve problems of heat radiation and wear caused by air-borne particles.

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Representatives in Principal Cities • ***In Canada:*** **Williams & Wilson, Ltd., Montreal, Toronto, Quebec, Windsor**

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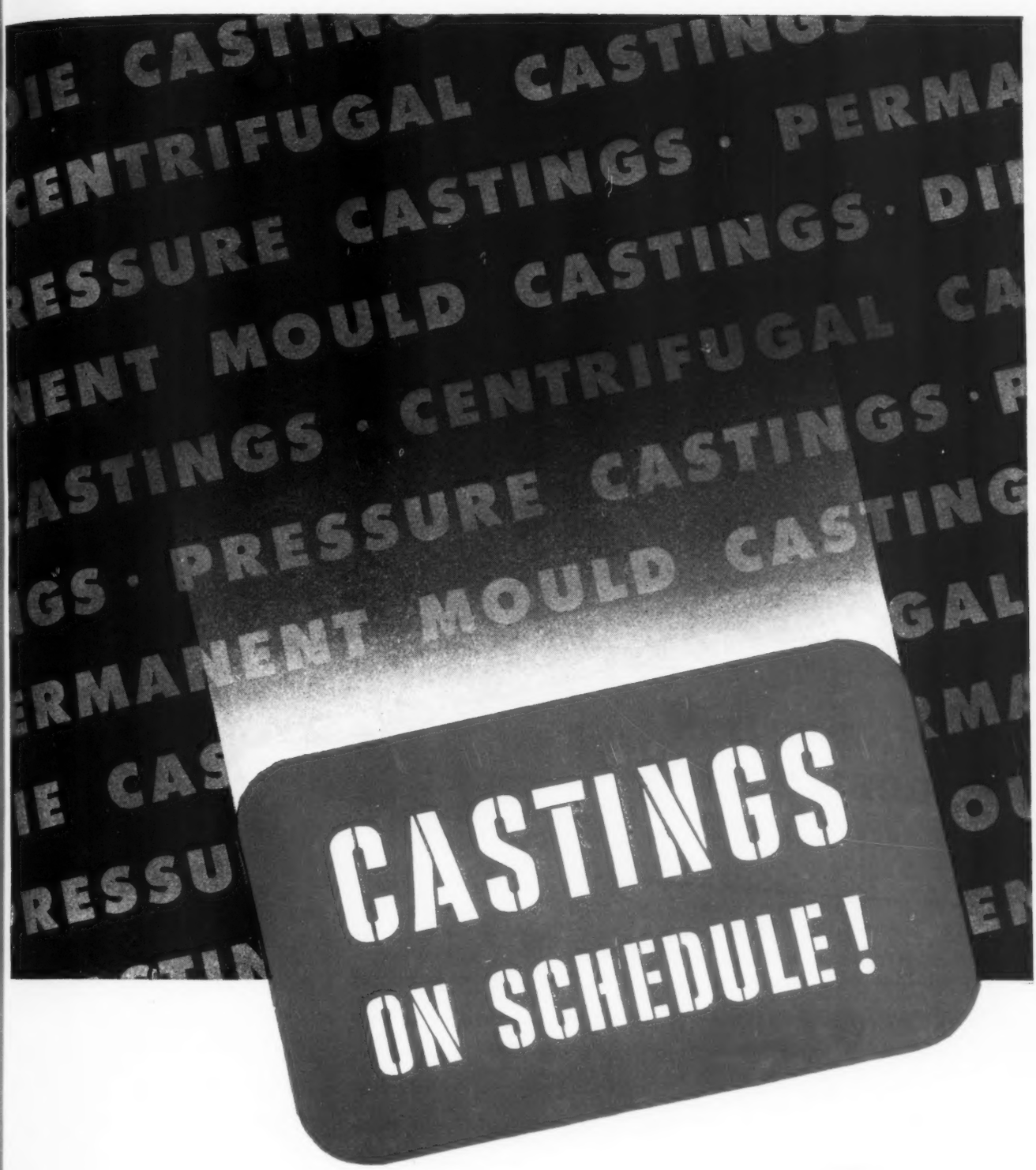

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PASS your hard-to-solve production problems along to Joyce—they're our dish. We don't wish to imply that we *prefer* the difficult assignments to the run-of-mill jobs—what we want to establish is that we've had such broad experience in production procedure and product improvement that we're confident we can help you materially in meeting your war contracts—and in your postwar planning. Whether it be the designing of special machines or the quantity production of products or parts, Joyce's extensive facilities are available to assist you.

Joyce's huge force of skilled craftsmen have proved themselves in maintaining a constant flow of war materials for the Army, Navy, Maritime and Aircraft services—and their ability to get things done has helped many of the country's leading industrial plants score enviable production records.

A Joyce representative will be glad to explain in detail the many phases of Joyce's design, assembly and fabricating service. If it can be made better, faster, more economically, Joyce "know how" will find the way.

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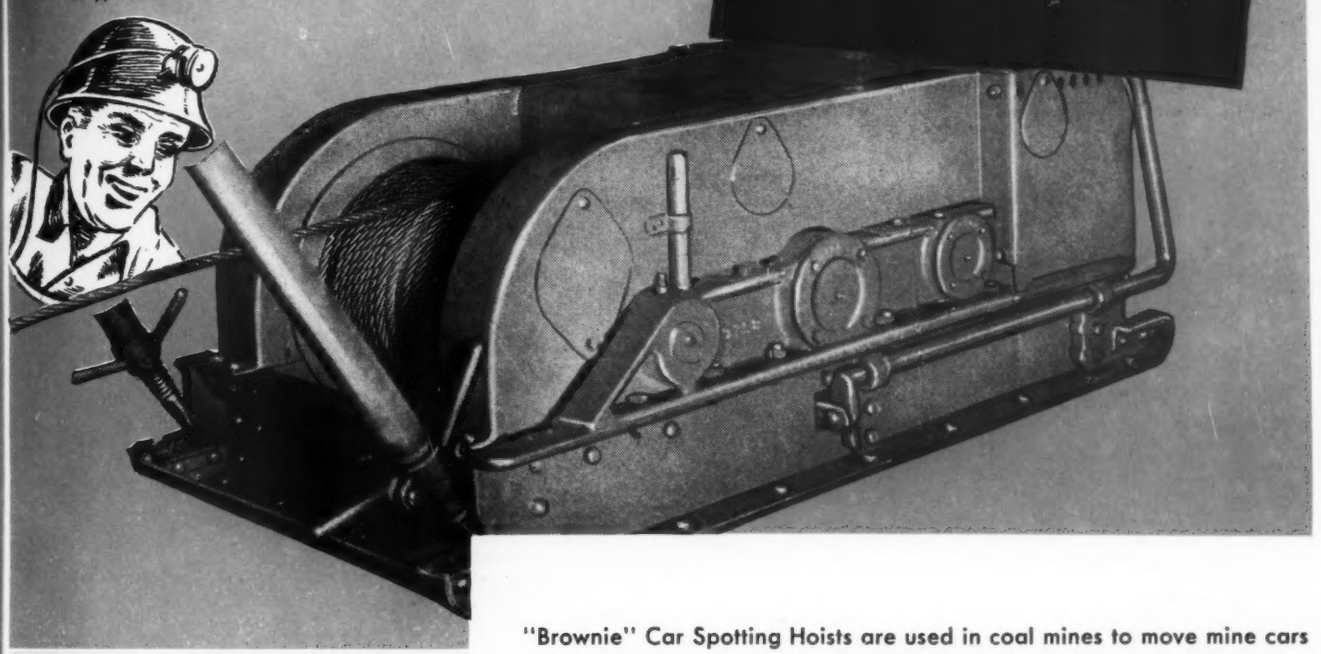
MANUFACTURERS OF PRECISION PARTS
FOR ALL KEY INDUSTRIES

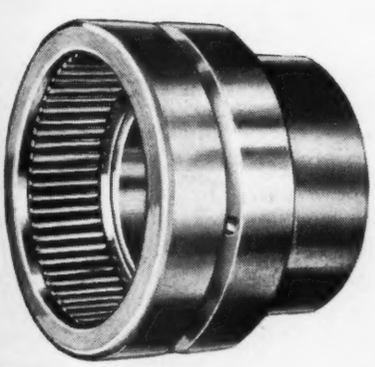
IN "BROWNIE" CAR SPOTTING HOISTS—

The Rope Drums Roll On

ORANGE ROLLER BUSHINGS

The Model HKL "Brownie" Car Spotting Hoist, made by the Brown-Fayro Co., Johnstown, Pa., has a rope pull of 6000 lbs. at 25 ft. per minute (equal to the pull of a 10 ton locomotive). Orange Roller Bushings are used in the Rope Drums which rotate on a stationary shaft. Drum has 10" core dia., 17¾" flange dia., 17¾" face width.





"Brownie" Car Spotting Hoists are used in coal mines to move mine cars past conveyors and loaders. Operating in coal seams having low head-room, this powerful machine is built to extremely compact design.

The bearing installation in the Rope Drum is a "natural" for Orange Roller Bushings, noted for their exceptionally high load carrying capacity in small space—and for their even, quiet, long-life operation in severest service.

Orange Roller Bushings are available in a full range of sizes and types, with or without race. Send coupon for Engineering Data Book giving full details of design, types and sizes, plus installation data.

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Please send me your Roller Bushing Data Book

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City..... State.....

ORANGE ROLLER BEARING CO., INC.
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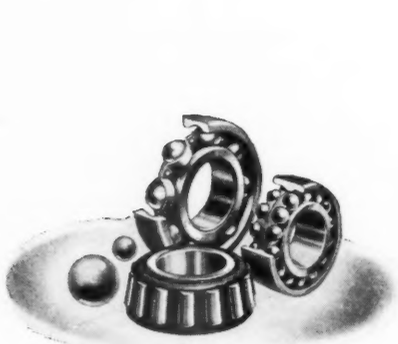
THE PROMISE OF TOMORROW

Today, on land, sea and in the air Hoover products are fighting for a brighter tomorrow. They are serving in the frozen wastes of Russia and on the scorching sands of Africa. Today in aircraft, guns, ships, tanks, bombs that are in use by the United States Navy, Army, Signal Corps, Air Corps, Marine Corps and the United Nations, Hoover products are fighting to assure a tomorrow when we can again return to our way of life.

Hoover products are fighting for a tomorrow when peace will reign again all over the world. A tomorrow when we may once more build the

products of peace time living, and make them finer and better than ever before. When that day comes there will be no more shortages, delays, priorities. There will be no need of a second choice when buying balls or bearings. The facilities we have expanded and developed to help win the war will be at your complete command to supply bearings for those new super-machines you are designing now, and which you will bring out when peace comes, to maintain leadership in your industry. Today Hoover products are fighting for that tomorrow.

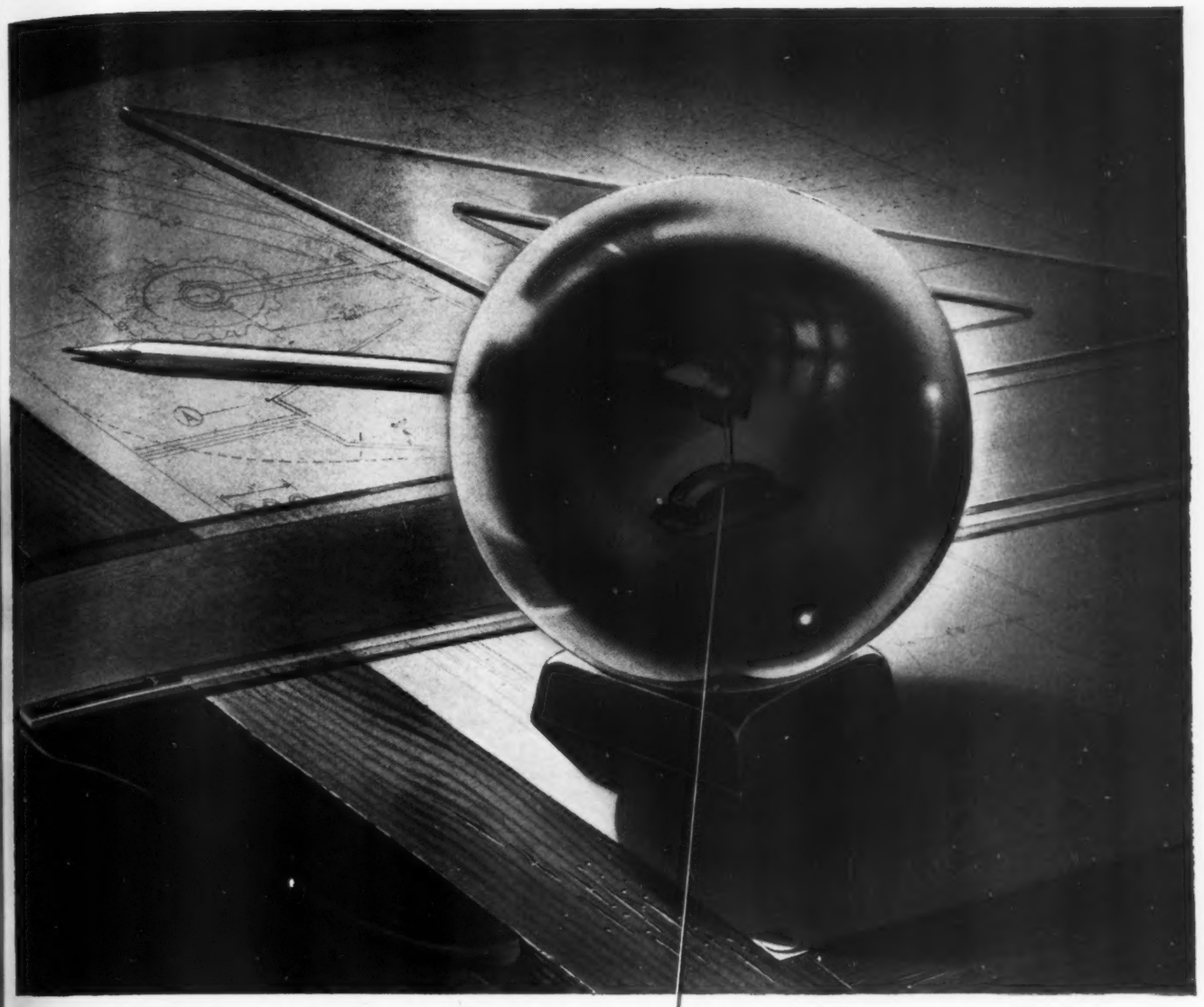


HOOVER

THE ARISTOCRAT OF BEARINGS

Balls - Ball Bearings - Roller Bearings

HOOVER BALL *and* BEARING CO., Ann Arbor, Mich.



The Future begins with yesterday

There has been a lot of day-dreaming about the world of tomorrow, and how different it will be. But the best prediction of the future is provided by a review of the past, and the soundest guide as to how and where W·A·B Remote Controls can help you to boost tomorrow's production, and improve tomorrow's products, is found in the things the controls have done and are doing.

W·A·B Remote Control Systems are working on production equipment in machine shops, mills and foundries, simplifying, lightening and fool-proofing such operations as loading, chucking, hold-down, molding, and feeding.

They are serving on conveyor systems, where they permit centralized dispatching, timing and switching.

They are in use on shovels, hoists, cranes and similar equipment, eliminating the heavy work usually associated with the operator's job, and adding an important safety factor.

They are installed on a large number of ships, where they permit the most precise control of speeds, and concentrate control of all maneuvering operations under the hands of a single operator.

In your thinking about the improvement of products and production methods to meet post-war needs and competition, you will find it profitable to consider W·A·B systems wherever a control problem is involved.

Westinghouse Air Brake Company

INDUSTRIAL DIVISION

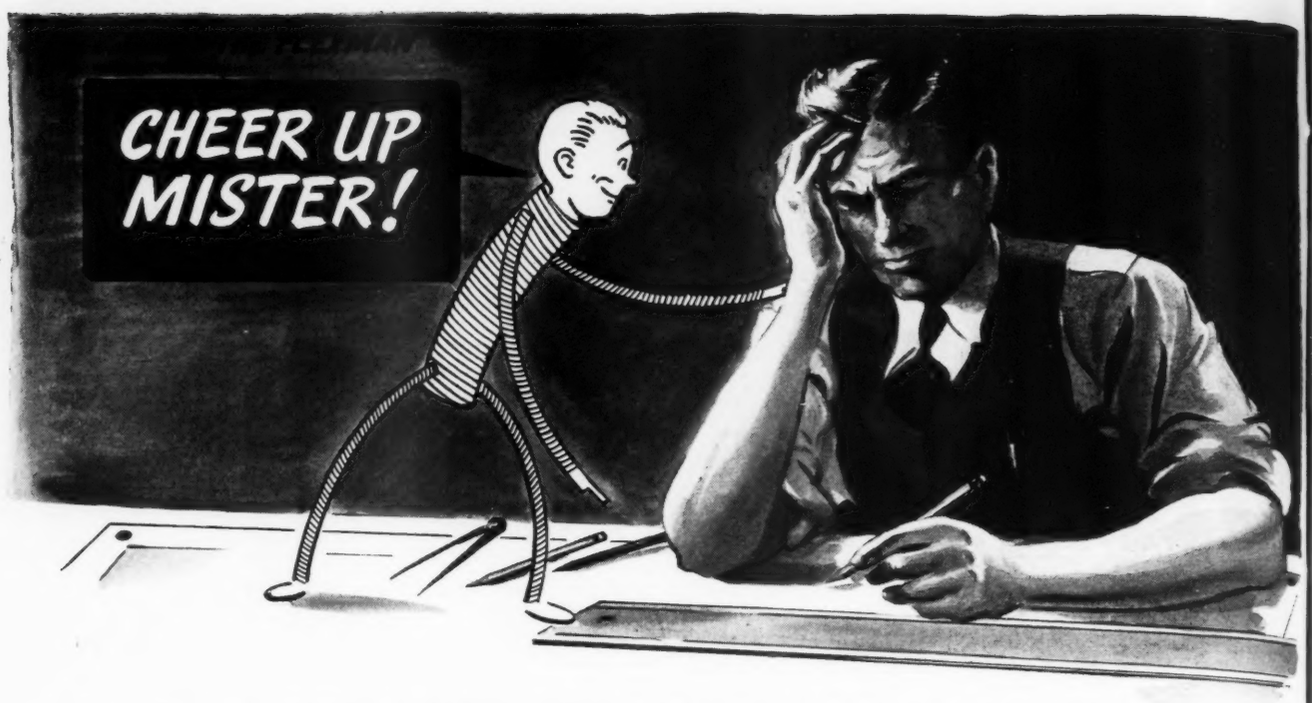
General Offices: Wilmerding, Pa.

74 Years of Pneumatic Control Experience

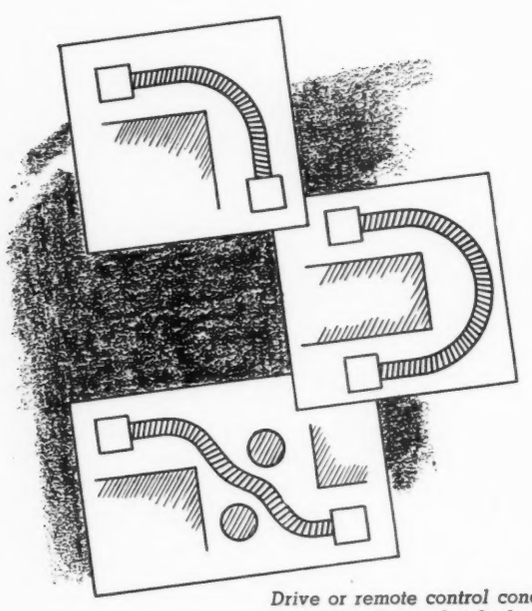
W·A·B

Pneumatic, Pneumatic-Electric, Pneumatic-Hydraulic

CONTROL SYSTEMS



an S.S. WHITE FLEXIBLE SHAFT is the answer to that drive problem



Drive or remote control conditions like those sketched are "duck soup" for S. S. White Flexible Shafts.

Yes, when your problem is the mechanical transmission of power, an S. S. White flexible shaft may well be the answer—and just about the simplest answer you can get—a single, easily applied element that will take power from your power source and deliver it to the part you want to drive wherever that part may be located. Turns, obstacles or distance make no difference to a flexible shaft.

The wide latitude a flexible shaft gives you in the placing of driving and driven members often enables you to work out more efficient designs, and its simplicity means faster production and lower costs. There are hundreds of applications to prove it, in aircraft, motor vehicles, radio and electrical equipment, stoves and ranges, machine and portable tools and a wide variety of other products.

It will pay all design engineers to become familiar with the range and scope of S. S. White Flexible Shafts. These Bulletins will give you the data.

BULLETIN 1238—Power Drive Flexible Shafts.

BULLETIN 38-42—Remote Control Flexible Shafts.

Copies mailed to you on request.

S. S. WHITE

The S. S. White Dental Mfg. Co.

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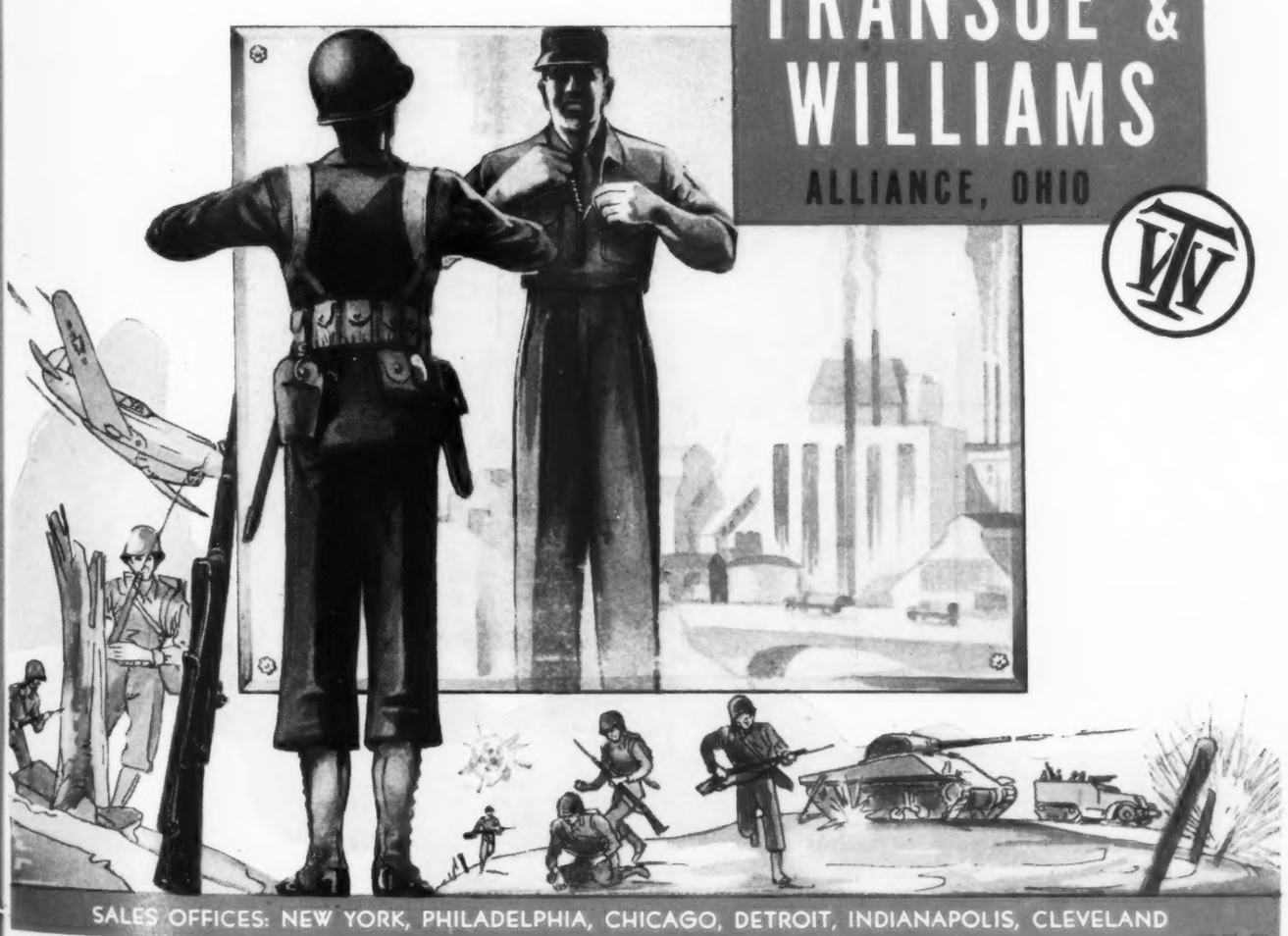

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It spreads or contracts without distortion; always retaining its perfectly fitting circular contour.

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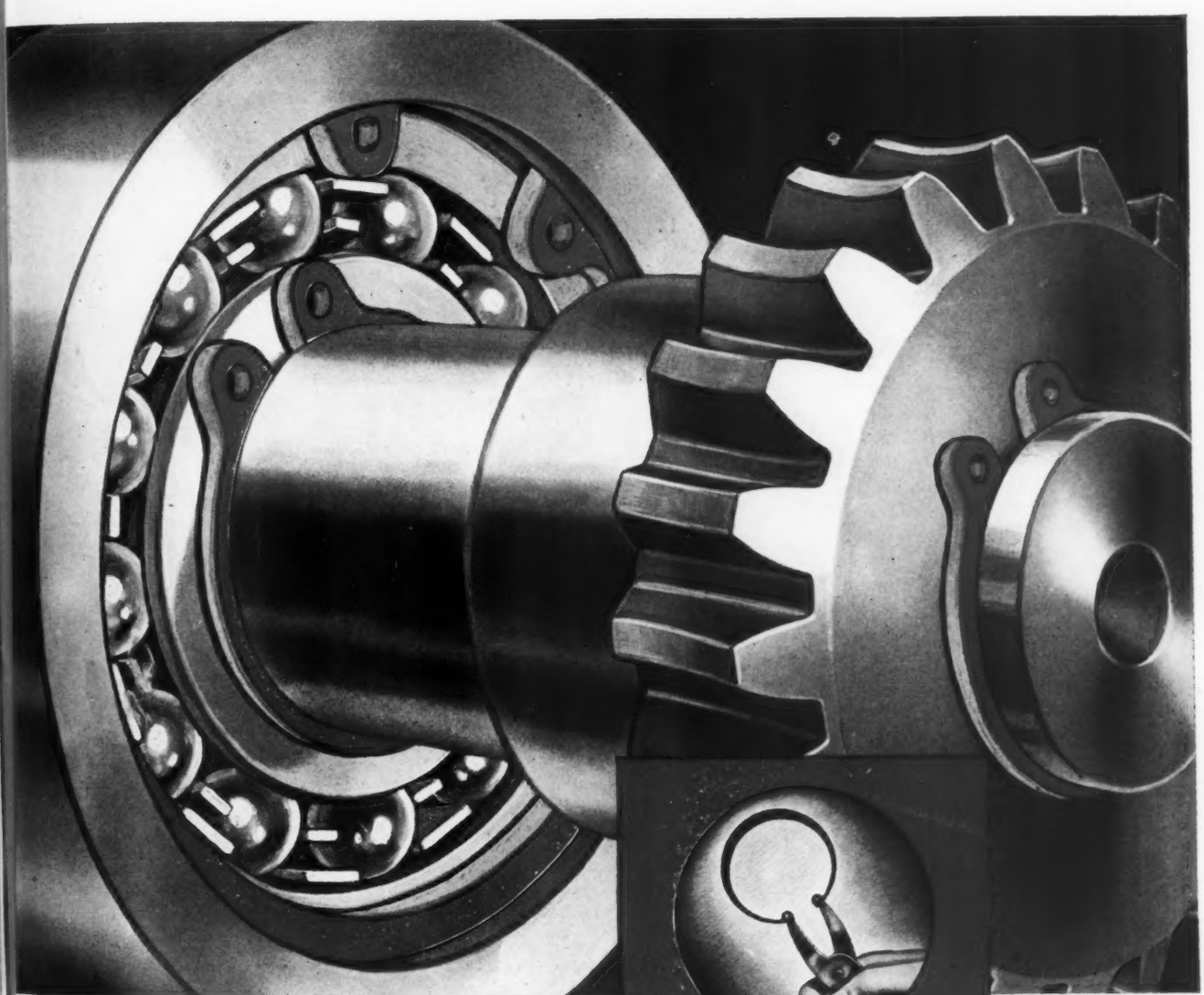
For thrust-load fixing, and shaft and housing applications, Waldes Truarc provides distinct advantages over nuts and bolts or wedges and washers... it reduces dimension and weight... saves material... cuts manufacturing time... simplifies assembly and dis-assembly.

On request, we will gladly furnish samples and full data for your tests.



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Re 18,144
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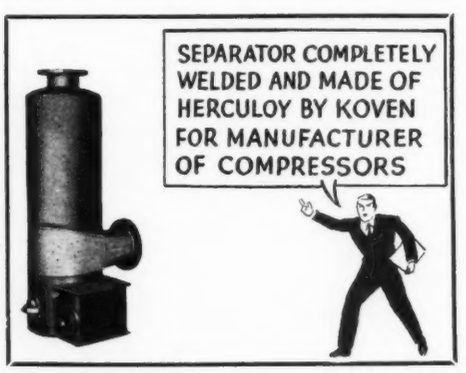
WHILE working at top efficiency toward the war effort, KOVEN engineers are making every spare moment count by filling it with study of the possible problems of tomorrow's peacetime production and plans for their solution.

KOVEN is ready to serve you today by building the individualized equipment parts you need, perfectly designed and constructed. You can depend on KOVEN to produce — to your specifications — any parts which are difficult or too costly to manufacture in your own plants.



Whenever you have a problem with a part or parts of your equipment, KOVEN'S staff of expert engineers, with over half a century of fabricating experience, will be pleased to cooperate with you.

Write or phone for a KOVEN representative to call.

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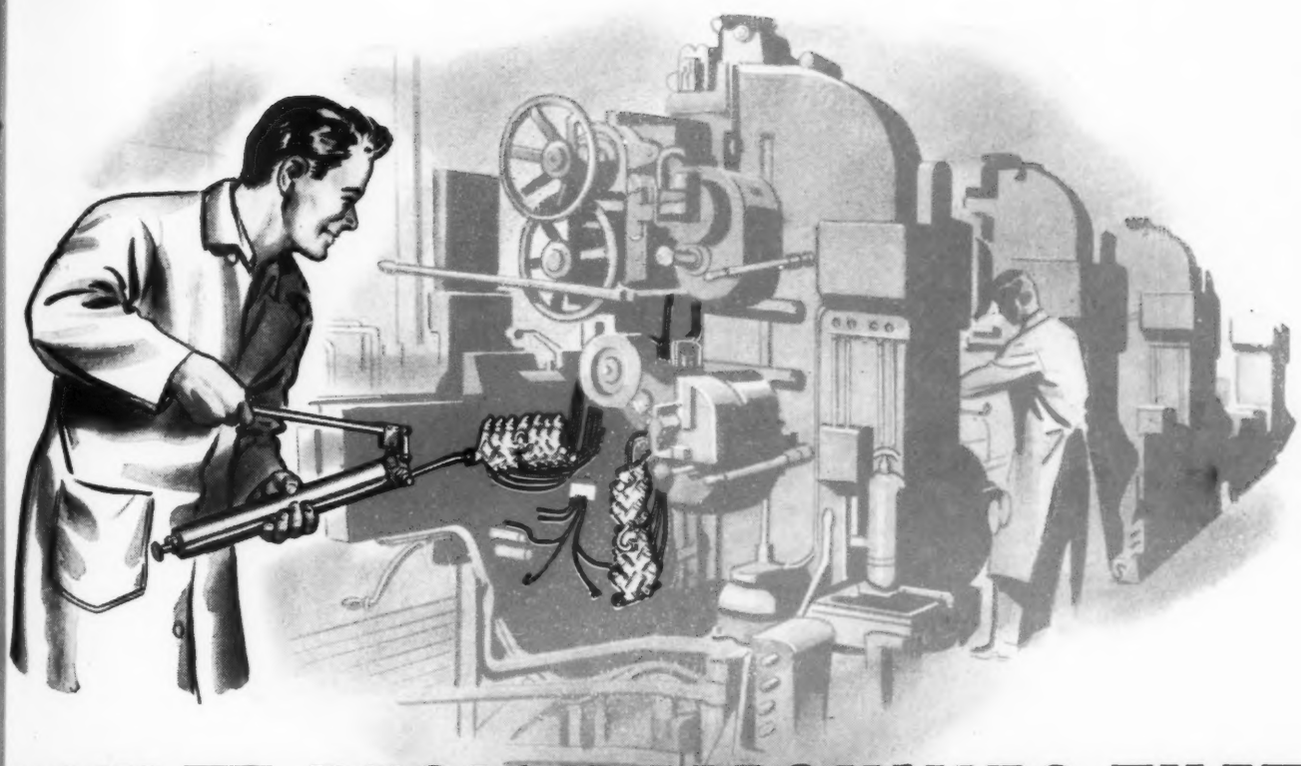

HOW TO DESIGN MACHINES THAT NEVER STOP FOR LUBRICATION!

It's Being Done Every Day

For instance: With Alemite Progressive Systems, one war plant reduced lubricating time on big lathes from 18 minutes per lathe each shift to 1 minute every six days. Another plant added 1 hour of production per day to huge presses because the machines *never stopped* for lubrication!

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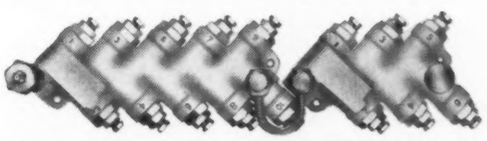
The Alemite Progressive System serves all bearings, no matter how remote, with one "shot," from one location on the machine. It delivers a pre-determined quantity of grease to each bearing and signals when finished.

During lubrication the machines *continue* operating . . . not a minute of production time is lost. The Alemite Progressive System is accurate and dependable. You know *positively* that every vital part is getting the lubrication it needs when it needs it.

Today, more and more plant operators are buying machines equipped with Alemite Progressive Systems. That's why an increasing number of machine designers and builders are offering Alemite Progressive Systems as standard equipment on their products. Write today for complete details.



Alemite Progressive Systems are available in from 3 to 20 outlets. Up to 20 bearings may be lubricated from one central point.

Ask Anyone in Industry!

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"I'm a GIBSON GIRL"

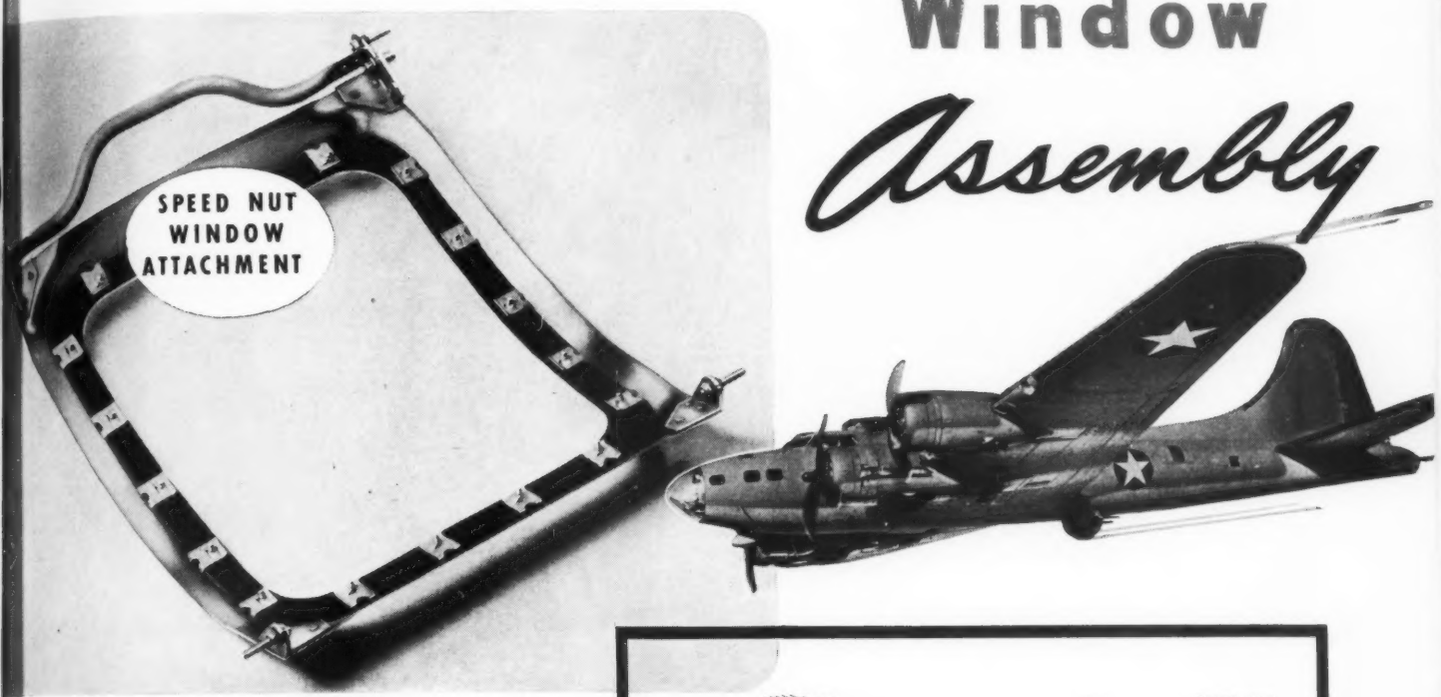
"My name isn't in lights, my costume is only a work-jumper—but the production is a hit nevertheless.

"I help to make springs for war—and they're good springs, too. I know, because it's my job to inspect them—and there are very few rejects. There can't be! Metal is precious and we've got to make every ounce count.

"I never realized how many springs are needed to run a country. Some of our machines go steadily, day in and day out, on one type of spring. It's good to know that wherever they wind up, Gibson springs have the stuff it takes to help win battles in the air, on land or sea."

THE WILLIAM D. GIBSON CO.
DIVISION OF ASSOCIATED SPRING CORP.
1800 Clybourn Avenue, Chicago, Illinois

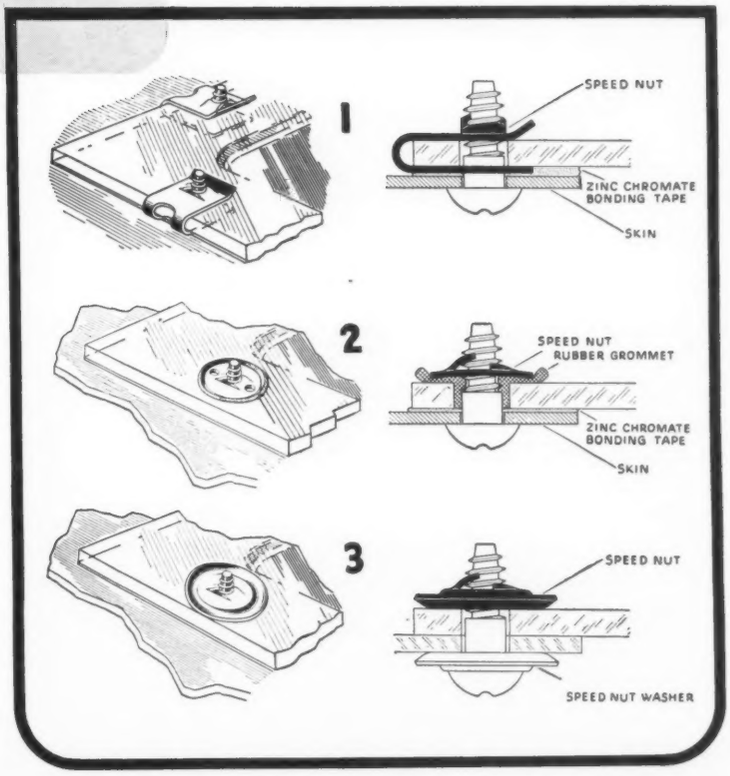
Speed Nuts IMPROVE Plastic Window Assembly

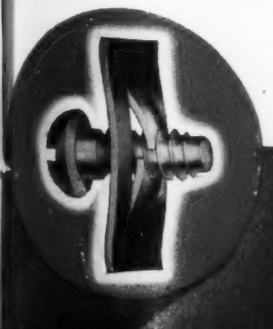


SPEED NUTS answer the problem of attaching plastic windows without danger of fracturing. They provide a spring-tension grip that frees the assembly from dead-tight fastening pressure. They also hold the plastic firmly in locked position under vibration and permit expansion and contraction of the plastic without damage. Washers are not needed as the wide bearing surface of the SPEED NUT spreads the load over a greater area and away from the screw hole. These SPEED NUTS are also applied faster—saving many manhour's time and reduce the net weight of the assembly.

In the first case illustrated, a "U" type Speed Nut snaps over plastic edges in self-retaining position. A round type Speed Nut is used in the second installation with rubber grommets in larger screw holes for additional cushion and seal. In the third method, where 2 pieces of plastic overlap, a cup-shaped Speed Nut is used with a mated Speed Nut washer—both formed to extend the load farther from the screw hole.

In writing for samples kindly give engineering details.

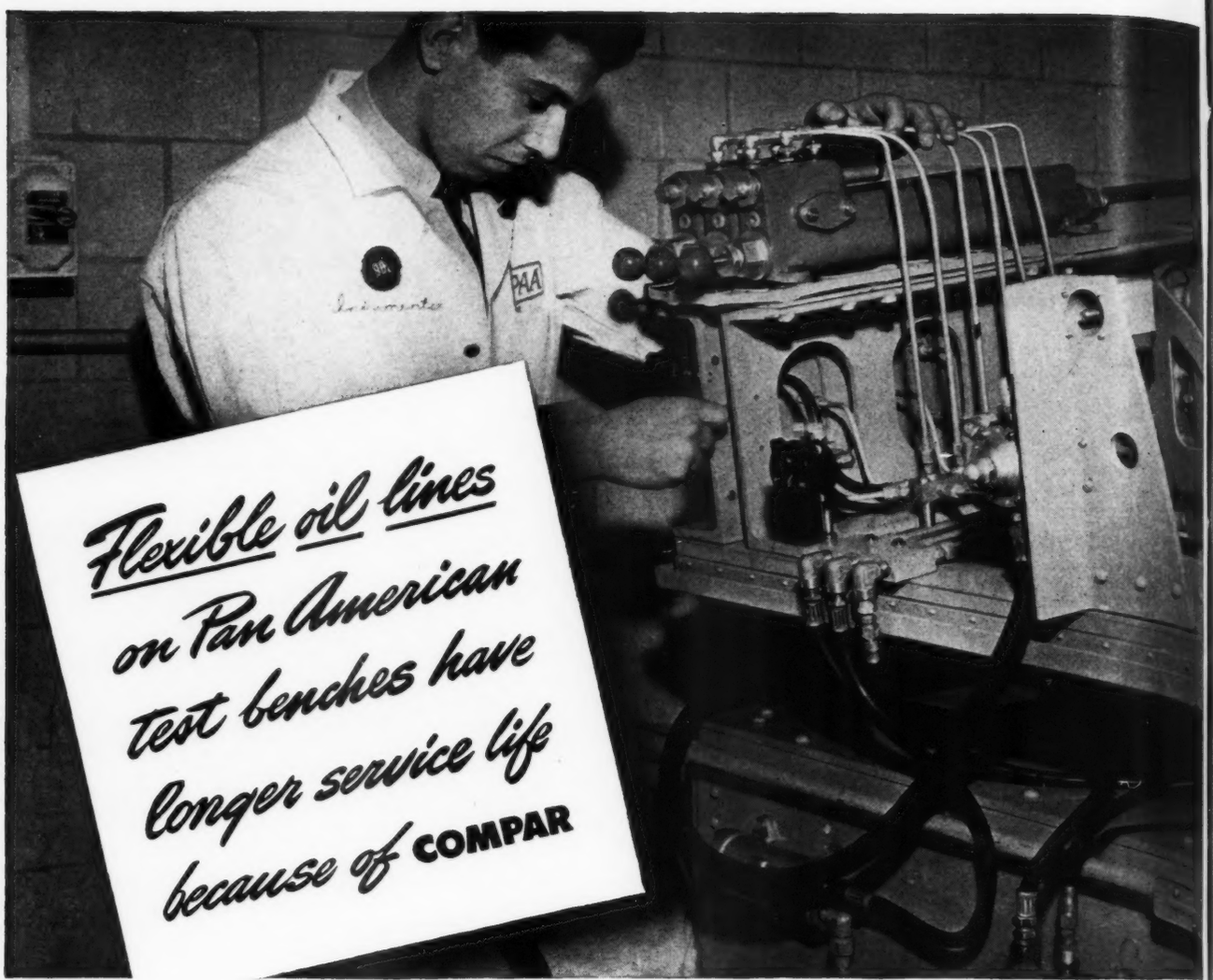




TINNERMAN PRODUCTS INC., 2041 Fulton Road, Cleveland, Ohio

IN CANADA: Wallace Barnes Co., Ltd., Hamilton, Ontario • IN ENGLAND: Simmonds Aerocessories, Ltd., London

THE FASTEST THING IN FASTENINGS!



TEST bench performance is up, flexible oil hose renewals down, at Pan American World Airways . . . for PAA now uses Resistoflex hose with its COMPAR core. And COMPAR is completely impervious to oil attack.

Various formulations of COMPAR are immune to lubricants, gasoline, aromatics — in fact, to organic solvents in general. This unique elastic plastic does not swell to pinch off the flow of fluid...does not slough or erode to clog the lines. Its glass-smooth surface keeps turbulence and skin friction down to a minimum.

And that's not all. Resistoflex hose is extremely flexible . . . lighter yet far stronger than other lines of similar construction . . . highly resistant to shock loads, vibration, and fatigue.

There may be a place in *your* product where these unusual service features of Resistoflex hose can be utilized to good advantage. For full details, write for the Resistoflex Industrial Catalog.

GLOVES PROTECT BOTH SKIN AND METAL

Safeguards against dermatitis for the worker — protection against damage for metal parts — Resistoflex Dual-Purpose Industrial Gloves give both. Made of COMPAR, the same elastic plastic that gives Resistoflex hose its unique properties, these gloves are impervious to organic solvents. Containing no sulphur, they will not tarnish highly polished metal parts, are ideal for delicate inspection work. Write for full details.

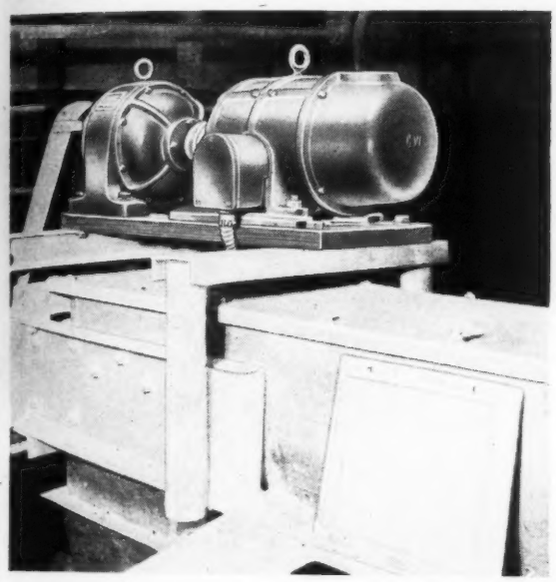
RESISTOFLEX

HOSE AND HOSE ASSEMBLIES FOR HYDRAULIC OILS AND VACUUM, FUELS AND LUBRICANTS, ORGANIC SOLVENTS, PAINTS AND LACQUERS, THINNERS, REFRIGERANT, NATURAL AND MANUFACTURED GASES—LABORATORY TUBING—DIPPED AND MOLDED MECHANICAL GOODS—COATINGS, SOLUTIONS AND PROTECTIVE CLOTHING

RESISTOFLEX CORPORATION, BELLEVILLE, NEW JERSEY

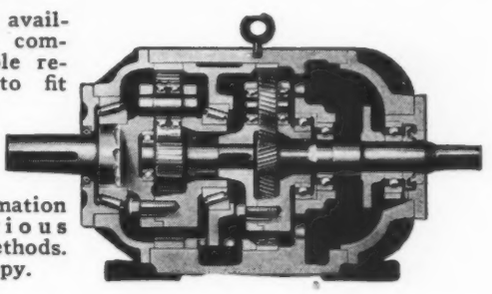
Why IS THE PHILADELPHIA PLANETARY REDUCER THE *RIGHT CHOICE* FOR A STRAIGHT LINE DRIVE?

The principle of the Planetary design was proved efficient, dependable and highly practical by Philadelphia MotoReduceRs. Those complete motor and speed reducer drive units employed the planetary construction. So well have they performed in the past dozen years that a demand was created for the same type of reducer for use where a separate speed reduction unit was indicated. This demand is being met by the Philadelphia Planetary Reducer which embodies the same features, parts and precision manufacture as the MotoReduceR.



Philadelphia Planetary Speed Reducers are compact in design yet rugged in construction. Input and output shafts are in line.

These units are available in single, compound and double reduction types to fit a variety of needs.



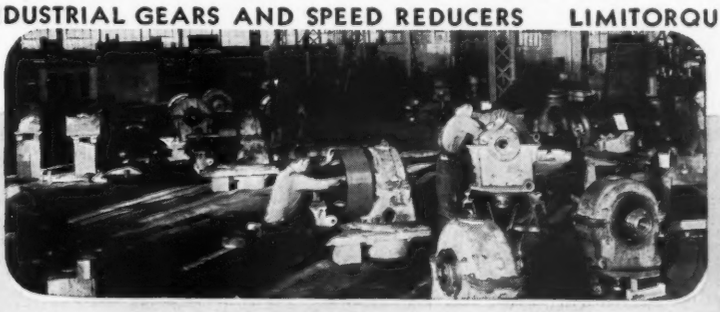
Our catalog 100 gives more complete information and shows various mounting methods. Write for a copy.

ARMY E NAVY

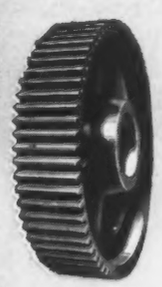
PHILADELPHIA GEAR WORKS, INC.

INDUSTRIAL GEARS AND SPEED REDUCERS LIMITORQUE VALVE CONTROLS

ERIE AVENUE & G STREET
PHILADELPHIA 34, PENNA.
NEW YORK, PITTSBURGH, CHICAGO



***Philadelphia* LIMITORQUE CONTROL**
operates all types of valves, etc., safely, economically, from convenient stations.

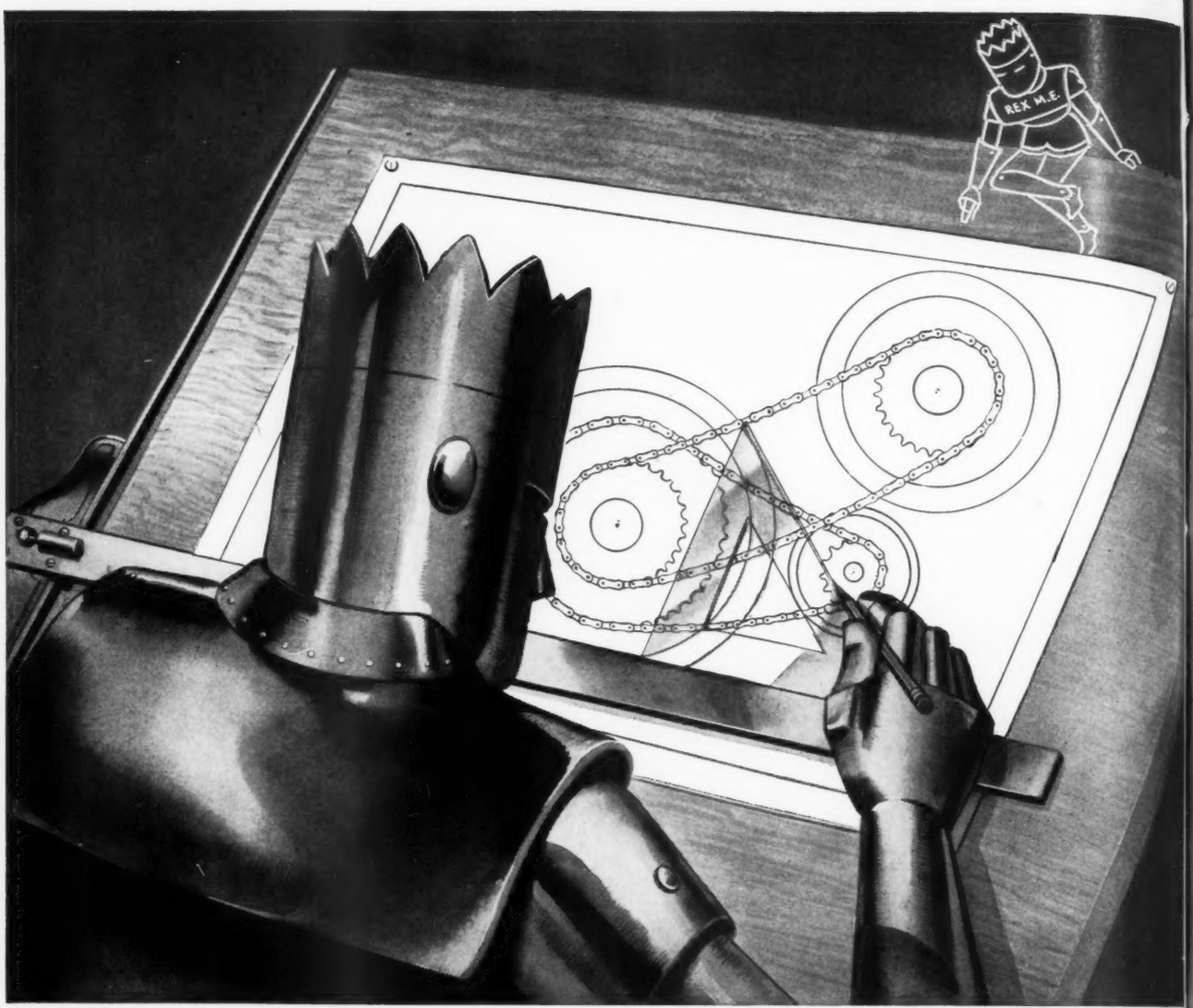


***Philadelphia* GEARS**
All types and sizes of industrial gears. Can be supplied in all materials.

***Philadelphia* HERRINGBONE SPEED REDUCER**
for heavy loads at high speed. Single, Double, Triple Reductions, various ratios and horsepowers.

***Philadelphia* MOTOREDUCER**
The economical self-contained drive, Horizontal or Vertical types — various ratios and horsepowers.

***Philadelphia* WORM GEAR SPEED REDUCER**
right angle drives — vertical or horizontal. Wide range of ratios and horsepowers.



He knows how HIS belts should be applied

Rex Mechanical Engineering—Rex M. E.—must necessarily be concerned with the *application* of his chain belts as well as with their design and manufacture.

He has known for many years that in designing a machine where the angular velocity ratio must be constant that *his* type of belt—the chain belt—will give closest to 100% efficiency. He also knows that proper application of this chain belt is vital, not only for producing this efficiency, but for long life of both machine and belt.

Rex M. E. is constantly studying the great variety of cases and conditions always confronting machine designers as they transmit power from one shaft to another. To help them he has designed more than 2000 types and sizes of chain belts.

To further assist machine designers to achieve maximum results at minimum cost and waste, he maintains a field organization which is well qualified to counsel and advise them. And back of his regional men is a skilled staff in Milwaukee who has the advantages of national experience.

Many of his 2000 types and sizes of chain belts and sprockets are described in his 768-page catalog. A letter addressed to Chain Belt Company, 1715 West Bruce Street, Milwaukee, Wis., will bring it to you.

REX **CHAIN BELTS**

In more than 2000 sizes and types for transmitting power, timing operations, and handling materials

CHAIN BELT COMPANY OF MILWAUKEE

BUY U.S. BONDS STAMPS

Believed to be the highest capacity right angle reduction gear ever produced by a *generating* process, this 97½ inch diameter, 192 to one, Cone-Drive is one of a war PRODUCTION order recently produced at one of the Cone-Drive plants in Detroit.

Equivalent in capacity to a *161 inch O.D. worm gear,* it was produced on standard Cone-Drive generating machines and is one of many other large Cone-Drive gear types (with diameters ranging up to 96 inches) being regularly produced—for war today—for peace "tomorrow".

Due to its high load capacity, Cone-Drive gearing, big as some of it comes, has made possible MORE COMPACT designs of war equipment than if other forms of gearing had been used.

For more information on this remarkable new form of gearing, ask for Manual CW-41A (for Executives), CW-41 (for design engineers)

CONE-DRIVE DIVISION MICHIGAN TOOL COMPANY
7171 E. McNichols Rd., Detroit 12, U.S.A.

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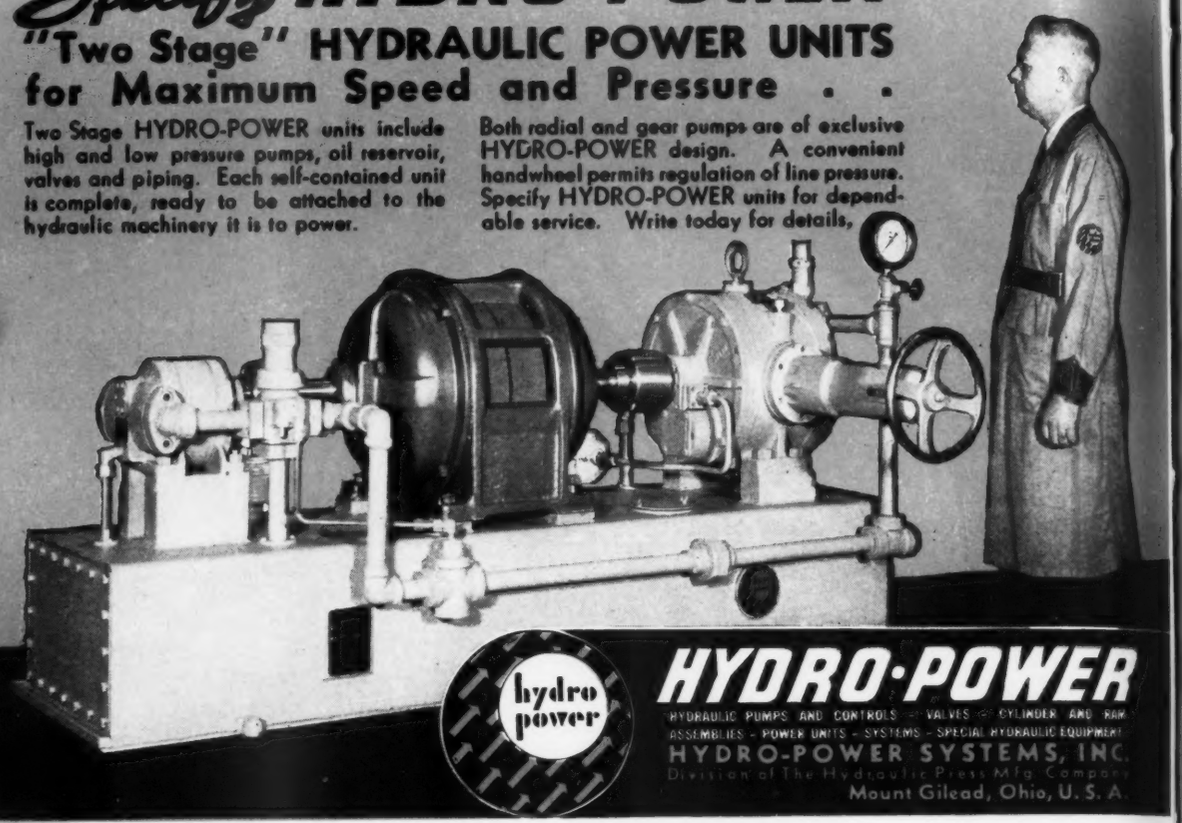
"Two Stage" HYDRAULIC POWER UNITS for Maximum Speed and Pressure . .

Two Stage HYDRO-POWER units include high and low pressure pumps, oil reservoir, valves and piping. Each self-contained unit is complete, ready to be attached to the hydraulic machinery it is to power.

Both radial and gear pumps are of exclusive HYDRO-POWER design. A convenient handwheel permits regulation of line pressure. Specify HYDRO-POWER units for dependable service. Write today for details.



hydro power

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HYDRAULIC PUMPS AND CONTROLS - VALVES - CYLINDER AND RAM ASSEMBLIES - POWER UNITS - SYSTEMS - SPECIAL HYDRAULIC EQUIPMENT

HYDRO-POWER SYSTEMS, INC.

Division of The Hydraulic Press Mfg. Company

Mount Gilead, Ohio, U. S. A.

Wishing You All a

MERRY CHRISTMAS

PRE-WAR STYLE!

PECK

SPRINGS

***and* SCREW MACHINE PRODUCTS**

The Peck Spring Company **14 Summitt St., Plainville, Conn., U.S.A.**

In war or peace
B.F.Goodrich
FIRST IN RUBBER

Rubber keeps the bell in the belfry

A typical example of B. F. Goodrich product development

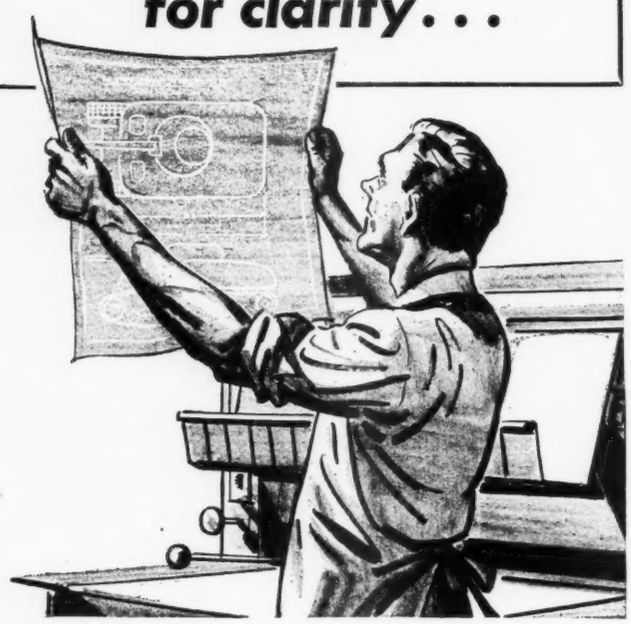
SOMEONE had made a mistake when the new church was planned. At the last moment, it was discovered that the old bell couldn't be used in the new belfry which just wasn't strong enough to stand the weight of the bell *plus* the vibrations sent forth every time the bell would be rung. Regretfully it was decided that the churchyard was the only place for the old bell.

But — fortunately one of the parishioners had heard of Vibro-insulators, the B. F. Goodrich mountings that can support industrial machines as though they are hanging or floating. Rubber layers are sandwiched between metal plates so that the weight of the machine gives a slight pulling or twisting action to the rubber. This way rubber can support more shock and vibration than when it is under compression. The bell was mounted on four standard Vibro-insulators. Not a quiver passed on to the belfry when the bell was rung. The bell stayed where it belonged.

You may not have a problem involving church bells. But if it involves vibration, investigate B. F. Goodrich Vibro-insulators. Made in 12 standard sizes, they vary in application all the way from mountings for giant stamping presses to protective devices for delicate instruments on battleships, giving longer life and essential accuracy to machines and instruments. *The B. F. Goodrich Company, Industrial Products Div., Akron, O.*

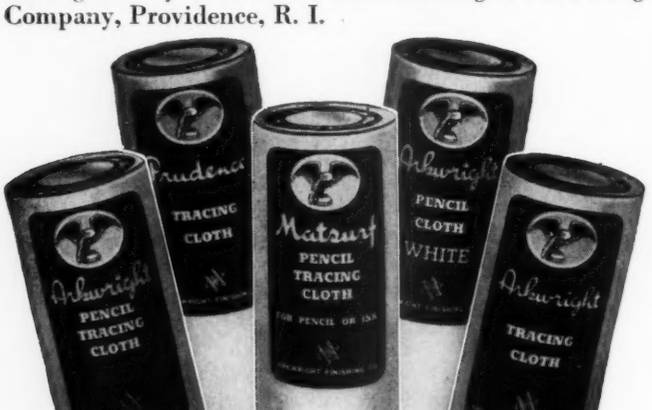
B.F. Goodrich
Vibro-insulators
SHOCK TROOPS OF INDUSTRY

The greater the need for clarity . . .



. . . the greater the need for
ARKWRIGHT TRACING CLOTHS!

If you want your drawings to reproduce clearly and sharply no matter how often they're run through the blueprint machine, use Arkwright Cloths. Highly transparent from the first, Arkwright Cloths always remain so . . . never become yellow or opaque with age. Try Arkwright Tracing Cloths yourself. See if they don't give you better transfer, sharper reproduction than any tracing cloth you've ever used. Arkwright Finishing Company, Providence, R. I.



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TRACING CLOTHS
AMERICA'S STANDARD FOR OVER 20 YEARS

. . . in World-Wide Aerial Warfare!

★ Pygmies in size, but giants in achievement are WILCO Thermometals (thermostatic bimetals) and WILCO Electrical Contacts.

★ Either paired with the correct WILCO Thermometal, or used alone, WILCO Aeralloy Aircraft Magneto Contacts are doing their part to assure *smooth* airplane performance. Other WILCO Electrical Contacts are giving equally dependable service in tank, ship and gun applications.

★ WILCO Thermometals, either separately or in conjunction with WILCO Electrical Contacts, are being used with the same success for aircraft oil temperature control and in various instruments for the Army and Navy.

BOTH AVAILABLE FROM ONE SOURCE

★ The facilities of THE H. A. WILSON COMPANY permit manufacturing customers to secure both electrical contacts and thermostatic bimetal from a single source. This is important because materials from these two groups are frequently used in conjunction, as parts in the same device. The most effective use of one necessitates a knowledge of the other. WILCO sales and engineering representatives are familiar with both Electrical Contact and THERMOMETAL application. Send us your problem for analysis.

WILCO PRODUCTS ARE: ***Contacts*** — Silver, Platinum, Alloys, Powder Metal. ***Thermostatic Metal*** — High and Low Temperature with Electrical Resistance from 24 to 530 ohms per sq. mil,-ft. ***Precious Metal Collector Rings*** for rotating controls. ***Jacketed Wire*** — Silver on Steel, Copper, Invar, or other combinations requested.

THE H. A. WILSON COMPANY
105 Chestnut St., Newark, N. J.
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WILCO

5 REASONS
(AMONG HUNDREDS)

why industry says "Look to Cook" to *quickly solve* your engineering problems

"IT *Can* BE DONE"
is the motto of Cook Engineers

Never have the facilities of the Cook Electric Company been so geared to new and unusual designs as today when pressed by the ever changing demands of wartime industry.

In the five switches illustrated here, Cook Electric Company has put all the ingenuity of a company to whom no design problem can be termed impossible.

Check over details of these five new switches, designed to fill specific needs and now in production for the general use of industry.

Whatever your engineering problem, Cook Electric's fine staff of forward-looking engineers are ready to build for you just the bellows or switching unit to serve your needs. We are at your service to tackle the new and unusual problem.

The Cook UX Pressure Switch (1) is ideal for applications under water or where explosive liquid or gas pressure variations should be detected. Water and explosion proof, this switch operates by means of a varying Bellows and Micro Switch arrangement. The heavy bronze case with rubber gasketed cover is gas tight and proof against heavy shocks or impacts. Leads are brought out through patented compression couplings. The UX Pressure Switch is adjustable to respond to 1¼" water column differential.

★

The Cook Low Pressure-High Amperage Switch (2) employs a large area bellows to record minute variations in line pressure. It operates a 28 ounce, 30 ampere S.T.D.P. Micro Switch with a range of 1½" to 10" water column with 1" differential. It is supplied with heavy current carrying terminals, hard rubber insulation and No. 12 B.S. flexible leads. A rigid frame permits several mounting adjustments and prevents distortion which may affect adjustments.

★

The Cook Strato-Switch (3) is designed to program a series of switch operations in any desired sequence of electrical operations. It is so named because it was first designed to control such sequences in the ascent and descent of a plane. It is shown here without wiring or cover.

★

The Cook Hydro Switch (4) provides a means of electrically detecting variations in high pressure hydraulic circuits for vessels. The bellows is enclosed in a heavy bronze casting so designed that the end plate of the bellows serves as a piston and absorbs an effective sudden surge. The armature has an adjustable cam which actuates a Micro Switch.

★

The Cook Thermal-Aire Bellows Switch (5) is designed for use in applications where extreme sensitivity is required. It can be operated by air, gas, steam, water or other fluids. It may have a differential as low as ¼" water column and adjusted to actuate from 1" water column to 30" water column. It is corrosion resisting, will withstand severe shock and vibration and is not affected by temperature variations. It can be mounted in any position without affecting the operation of the switch.

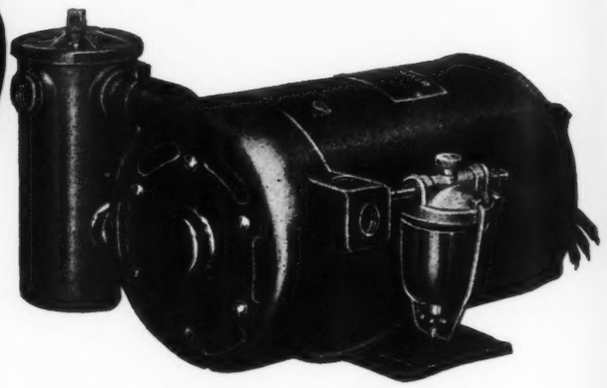
COOK ELECTRIC Company

"Spring-Life" Engineered Midget to Giant Size Bellows

2700 SOUTHPORT AVENUE • CHICAGO (14) ILLINOIS

In **PUMPS** *you get more advantages by using* **"MOTOAIR"**

less parts to wear out
less metal means less cost
DEPENDABLE
requires less space than
most motor-driven pumps



Motor and pump in *one* integral unit means that MOTO-AIR is not dependent upon central pumping plant, and is always ready for "plug-in" use. Available for wall, ceiling or normal mounting. Largely used by Industrial and Government plants, laboratories, and as cleaner-blowers.

MOTOAIR PUMPS have *visible* continuous, lubricating system. Motor and pump in ONE integral unit means NO gears; NO drives to wear out, no guards, and no large base. Made in a range of sizes, for various purposes.

Get Facts—and you'll get Motoair!

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Chicago Office
325 W. Huron St.

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Cutout shows locking ring. Pat'd and Pat's Pending.

Reg. U. S. Pat. Off.

BY THE UNSHAKO SELF-LOCKING NUT

. . . and the "Unshako" plays no favorites. The built-in self energizing locking ring never relaxes its hold . . . yet the "Unshako" can be readily backed off with a wrench and used over again as often as desired. Whenever applied, it clamps down with a relentless grip and positively prevents loosening under vibration. Write today for full details.

OVER 40 YEARS IN BUSINESS

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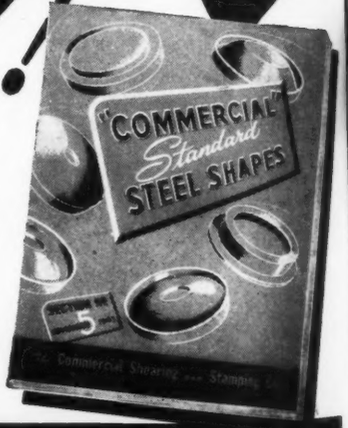
Now Ready for You NO 5

Buyers of stampings or tank heads will find Shape Book No. 5 invaluable, it lists parts for which tools are available at our plant.

If you did not get a copy. *Write us.*



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YOUNGSTOWN . . OHIO . . U.S.A.

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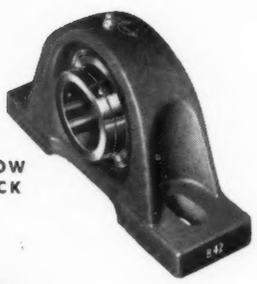
Specify

THESE FEATURES–

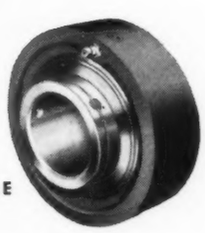
- PERMANENTLY SEALED
- PRE-LUBRICATED
- SELF-ALIGNING

SEALMASTER



PILLOW BLOCK

TAKE-UP UNIT



CARTRIDGE UNIT

BALL BEARING UNITS

● Products now contemplated by machine designers must be good if they are to succeed in postwar competition.

Bearings to be used on these products must likewise be of modern efficient design, fully capable of long useful service. SealMasters' exclusive features make them the logical choice for both new and re-designed products. SealMasters are permanently sealed to keep out dirt and retain lubricant. They are fully self-aligning, allowing several degrees of shaft mis-alignment in any direction.

Mis-alignment of the shaft cannot cause seal distortion, because the seal is part of the bearing proper and is independent of the housing.

SealMaster Units are pre-lubricated at the factory and are delivered ready for immediate service.

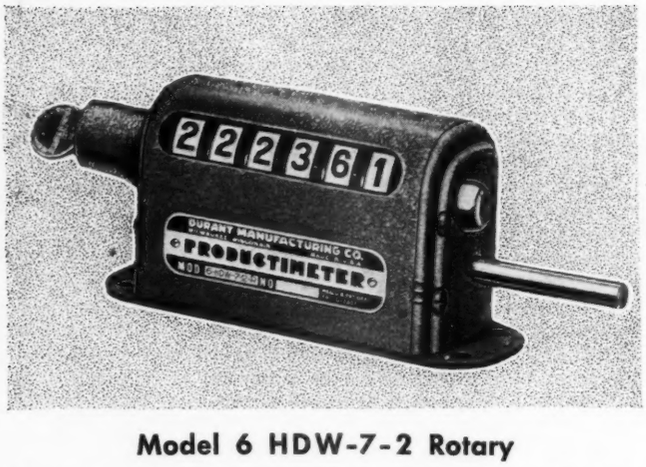
Investigate SealMasters advantages. Request Catalog 840 for full details.

STEPHENS-ADAMSON MFG. CO.
9 Ridgeway Avenue — Aurora, Illinois

BEARING DIVISION

STEPHENS-ADAMSON MFG. CO.

Factory Representatives and Dealers in All Principal Cities



Model 6 HDW-7-2 Rotary

A new recruit in the popular "H" series, the "HDW" is a sturdy, high-speed, streamlined counter . . . built for heavy duty . . . especially adapted for quick starting and stopping applications. Double-worm drive, oilless bearings, light weight, plastic wheels, hardened steel parts . . . assure smooth action and long service.

PRODUCTIMETERS
THE SPEEDOMETERS OF INDUSTRY

Design

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There is one more essential to be included in the plans for that new machine. It is not alone sufficient that it do the work required . . . production questions must also be answered . . . how much? how many? how long? Productimeters, designed as integral parts of machines, stand ready with the immediate, accurate answers . . . no matter what the counting problem may be.

The Productimeter Line is complete. Write for our recommendation covering your counting applications. Our advice is backed by 64 years' experience in the exclusive manufacture of counting and measuring devices.

Bulletin No. 100—a concise, ready reference catalog of 100 standard models—sent at your request.

DURANT MANUFACTURING COMPANY
1938 North Buffum Street
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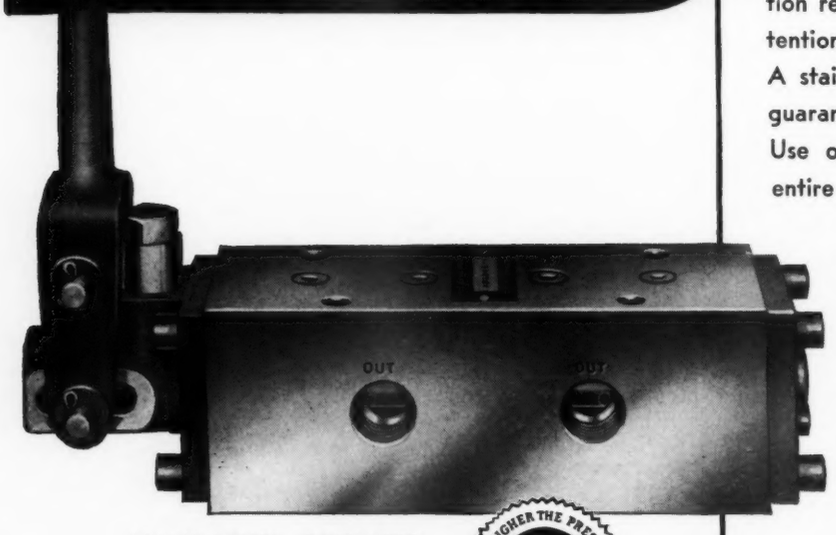
Quick-As-Wink VALVES



HAND-LEVER OPERATED

Also Mechanically Operated;
Pilot-operated Spring Return;
Double Pilot-operated.

THE HIGHER THE PRESSURE AIR WATER OIL THE TIGHTER THE SEAL

Single Plunger Control—
ONLY ONE MOVING VALVING PART

Simple yet sturdy Quick-As-Wink construction results in freedom from maintenance attention and more operations without repairs. A stainless steel plunger, only moving part, guarantees efficient operation at all times. Use of either bronze or stainless steel for entire unit eliminates corrosion and rust.

Installation is easy and the valve can be piped-up almost before you can say "Quick-As-Wink." Since main pipe connections need not be broken, future servicing offers no problem.

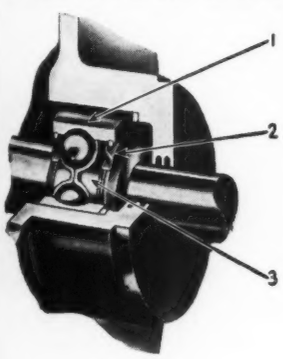
The Single Plunger type, recommended for air, water, or oil, operates to working pressure of 250 pounds. Send for catalog number 6. More than 50 different styles available.

C. B. HUNT & SON
1850 EAST PERSHING STREET · SALEM, OHIO

MAKING MOTORS *Last Longer...* Easy as 1, 2, 3 if they're *R&M Uni-Shell* INTEGRAL HORSEPOWER MOTORS

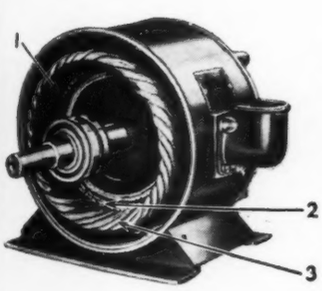
One of the two main reasons for motor deterioration is *bearing wear*. The second is two-fold: *poor insulation* and *excessive heat*. Both these primary causes of motor failure are conditions which R & M Uni-Shell Motors have been designed to eliminate. With them, you get wartime "day-in-*night*-out" trouble-free operating reliability . . . as easy as 1, 2, 3. This is why:

1·BETTER BEARINGS...



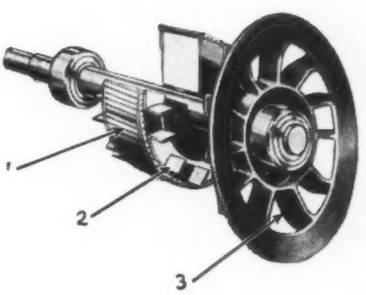
1. Double-row width bearings for greater lubricant supply. *2.* Complete seal, both sides . . . held in by snap rings that are quickly removable for inspection, cleaning, and regreasing. For trouble-free operation . . . keeps grease in . . . dirt out. *3.* Large grease reservoir for more lubricant . . . less maintenance.

2·BETTER INSULATION...



1. Two layers of highest-grade impregnated rag paper. Wire coated with double-weight synthetic resin for strength and flexibility. *2.* Added sheet of impregnated paper between coils in slot. *3.* Entire winding given several baked coats of synthetic resin-base varnish . . . covered with moisture-resistant synthetic resin and tung-oil sealer . . . guards against time-thieving breakdowns.

3·BETTER BALANCE and FAN CONSTRUCTION...



1. Ground rotor surface assures uniform air gap for quiet, smooth operation. *2.* Pressed-steel fans for larger ratings . . . on totally-enclosed motors . . . to provide greater cooling—longer life. *3.* Cooling fan produces maximum of measured cooling air flow for low-temperature, longer-life operation.

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MOTOR DIVISION, SPRINGFIELD, OHIO

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KIMBERLYS delight the draftsman—assure him of these unfailing qualities

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ALUMINUM
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With today's widespread adoption of die castings, users' requirements are seldom restricted to but one metal. As the new die casting alloys were developed, our customers requested "NEW PRODUCTS" quality in ALL FOUR metals. Our facilities were then expanded to the high production manufacture of aluminum, brass, magnesium and zinc high pressure die castings. Here you have ONE dependable source for "ALL FOUR"—plus a personalized service that saves valuable hours for you and your production department. We'll gladly assist with your production plans, present and future. Your inquiries are invited.

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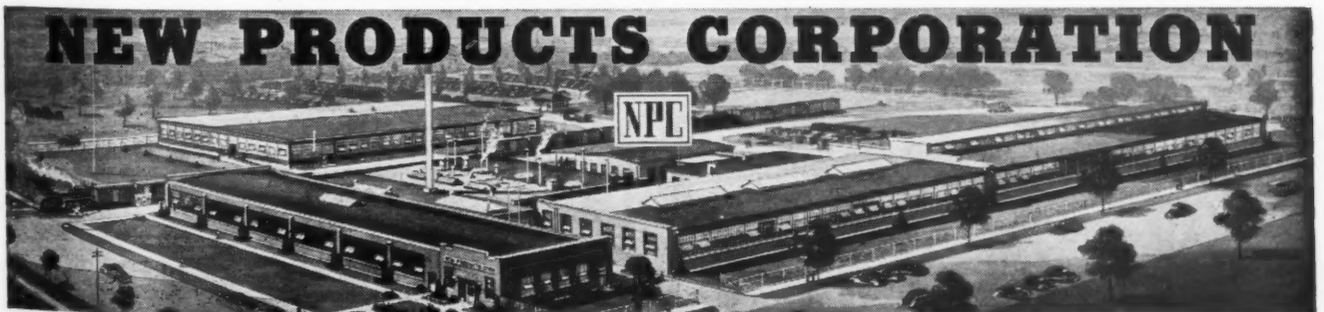
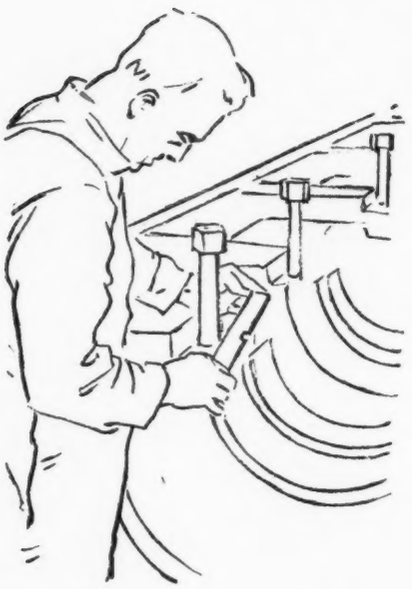


MAIN OFFICE AND FACTORY • BENTON HARBOR, MICHIGAN



factory accuracy *in field adjustments*

LAMINUM shims provide those quick-precision adjustments which—as in aircraft—are as vital in the field as in the original assembly.

Shims cut to your specifications. Stock shim materials obtainable from your dealer. Write us for further information and shim application chart.

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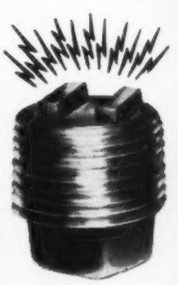
LAMINUM
THE SOLID SHIM THAT *peels* FOR ADJUSTMENT
2040

how to CUT bearing wear *on the drawing board!*

A NEW WAY to reduce wear to bearings and gears is now available to designers and engineers who are planning postwar products. It simply involves replacing ordinary drain plugs with Lisle Magnetic Plugs.

Here's how it works. A powerful magnet in the Lisle Plug catches and holds any iron or steel particles that may form in the lubricant as a result of ordinary wear. Removal of this abrasive metal reduces wear to vital parts; greatly prolongs the efficient life of your product.



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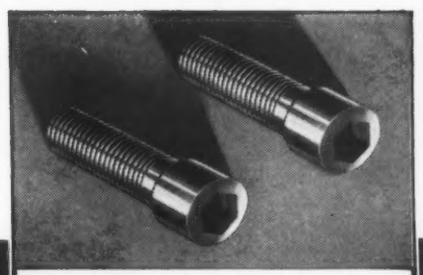
Box 1000, Clarinda, Iowa

Lisle Magnetic DRAIN PLUGS

Compare the *Quality-Control* and you'll say PARKER-KALON SOCKET SCREWS *Every time*



THESE SCREWS LOOK EXACTLY ALIKE

Only Quality-Control can *foretell* the DIFFERENCE

When tested in the P-K laboratory, one may be O.K., the other may fail. P-K Quality-Control makes sure you get *only* screws that are O.K.

This 16-Point "*Quality-Control*" check up --unequaled in the industry-- protects P-K Socket Screw users

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You get unusual protection against "doubtful" screws when you specify "Parker-Kalon" . . . and it costs no more. Parker-Kalon Corporation, 196 Varick St., New York 14, N. Y.

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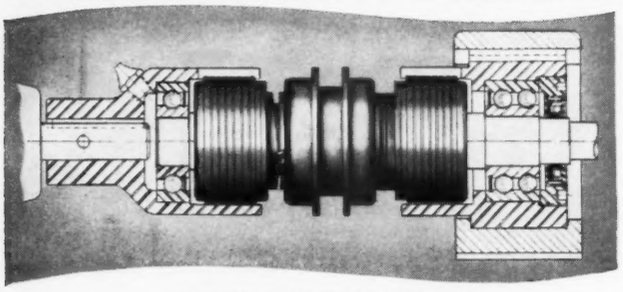
The double-type PULLMORE Multiple Disc CLUTCH can be arranged with one side for driving and the other side as a brake. This application provides an efficient brake which stops the driven shaft quickly. The cup on the brake is keyed, thus locking the shaft when the brake is engaged. This arrangement is specially suited for machines in which driven shaft speeds are high.



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Give capacities, dimensions and specifications. Contain application diagrams. Show HOW exclusive Rockford features are being used to help give post-war products competitive advantages.

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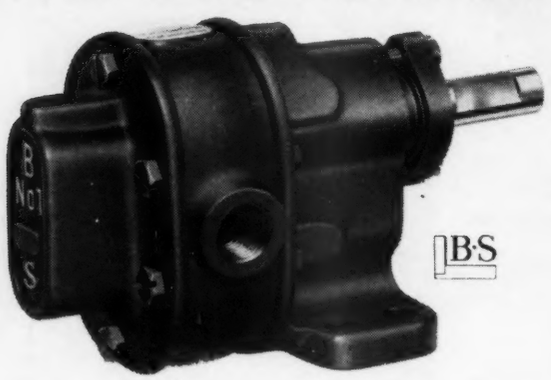
309 Catherine Street, Rockford, Ill., U. S. A.

Pullmore Clutches are sold by Morse Chain Co., offices in principal cities

COMPACT-RELIABLE-PRECISION BUILT



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— with capacities from ½ gallon to over 37 gallons per minute that meet practically every installation requirement. Spur, helical, herringbone gears. Some styles with antifriction bearings. For lubrication, supplying coolant, transfer purposes or for hydraulic installations. Positive and efficient.

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BROWN & SHARPE PUMPS

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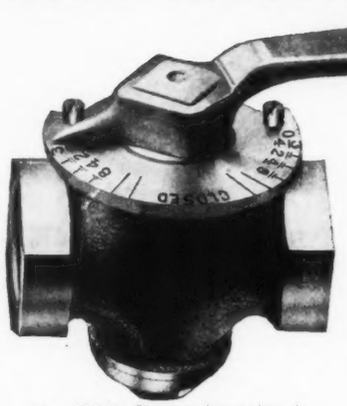


Fig. 293-B—Diamond-opening in plug
Fig. 293-C — Full straight-way opening in plug

Many new uses for this Hays' product have come to our attention recently. First designed and built for gas service it has been widely used to control the flow of liquids and gases. Made of Steam Metal — tested at 200 lbs. pressure. Have you a vital war application for it?

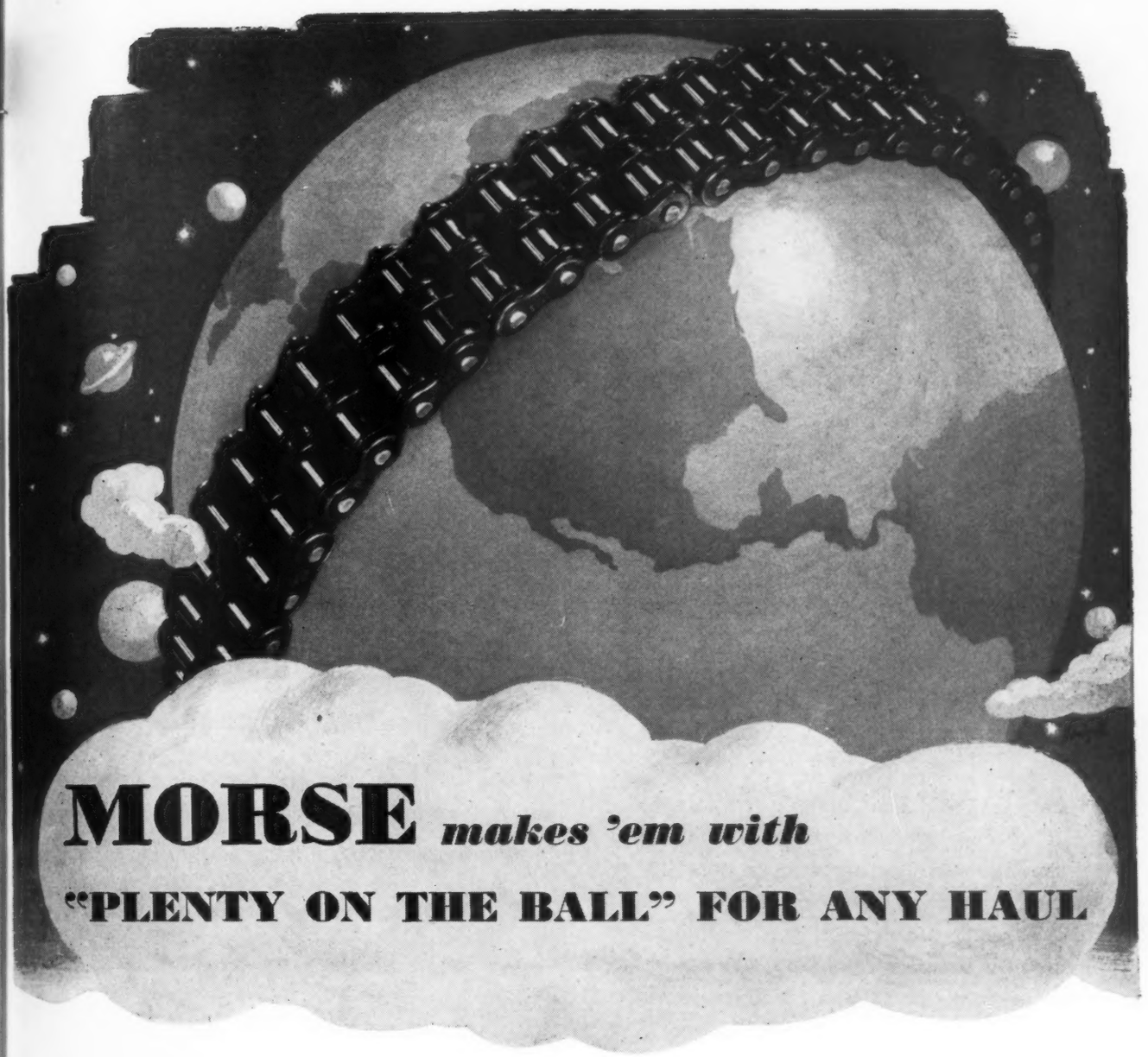
Sizes 3/8", 1/2", 3/4", 1", 1 1/4", 1 1/2", 2", 2 1/2", 3".

HAYS MFG. CO., ERIE, PA. • Since 1869

HAYS *Piping Products*

FOR LIQUIDS, STEAM AND GASES

The host of spring shapes made at B-G-R would keep the hardest-bitten "doodler" happy for life. Yet every bend or twist has a definite function—*or it wouldn't be there!* B-G-R spring engineers are "doers" *not* "doodlers"—when it comes to spring design. They are interested in making every spring perform a job—in the most efficient way. Even the simplest spring design may require the services of every department at B-G-R—from laboratory—to tool room—to machine—to heat-treating—to inspection. B-G-R's answer to spring complexities is—simplification. It saves time—materials—and tempers. Get the benefit of B-G-R spring skill today.



MORSE *makes 'em with*

"PLENTY ON THE BALL" FOR ANY HAUL

MORSE, with more than forty years' experience in the field of power transmission, is an important source of standard and special Roller Chain and Roller Chain attachments.

Today, the phrase "Plenty On The Ball" applies to Morse Roller Chain in more ways than one . . . because today, all around the world, Morse Roller Chain is at work in the automotive and ordnance equipment of our fighting forces. Further, Morse Roller Chain is proving that it has "plenty on the ball" for any haul, for any power transmission job.

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SPROCKETS CHAINS FLEXIBLE COUPLINGS CLUTCHES

MORSE Roller and Silent CHAINS

MORSE CHAIN COMPANY • ITHACA, N. Y. • DETROIT, MICH. • A BORG-WARNER INDUSTRY

The paper that hushed "studio noise"

A radio microphone is strictly impartial — it will pick up the "rattle" of script paper as well as the announcer's voice.

Taking the "rattle" out of radio script paper is a good example of specialized paper designing — an idea turned into a reality through laboratory research. Turning ideas into efficient, money saving and product improving realities is a specialty with Central — we have been designing and building industrial papers for 40 years.

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Eastern manufacturer of control equipment, transformers, solenoids, etc., desires ideas for postwar items . . . ideas which will help maintain our present 3,000 employees in postwar production.

If your idea is not fully developed, we will be glad to have our engineering division complete the p r o d u c t i o n details.

If you are interested in developing your idea in our laboratories, we will make arrangements accordingly.

Write Box BO-625 Product Engineering
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HELPING YOU,

THE KEY MAN IN INDUSTRY

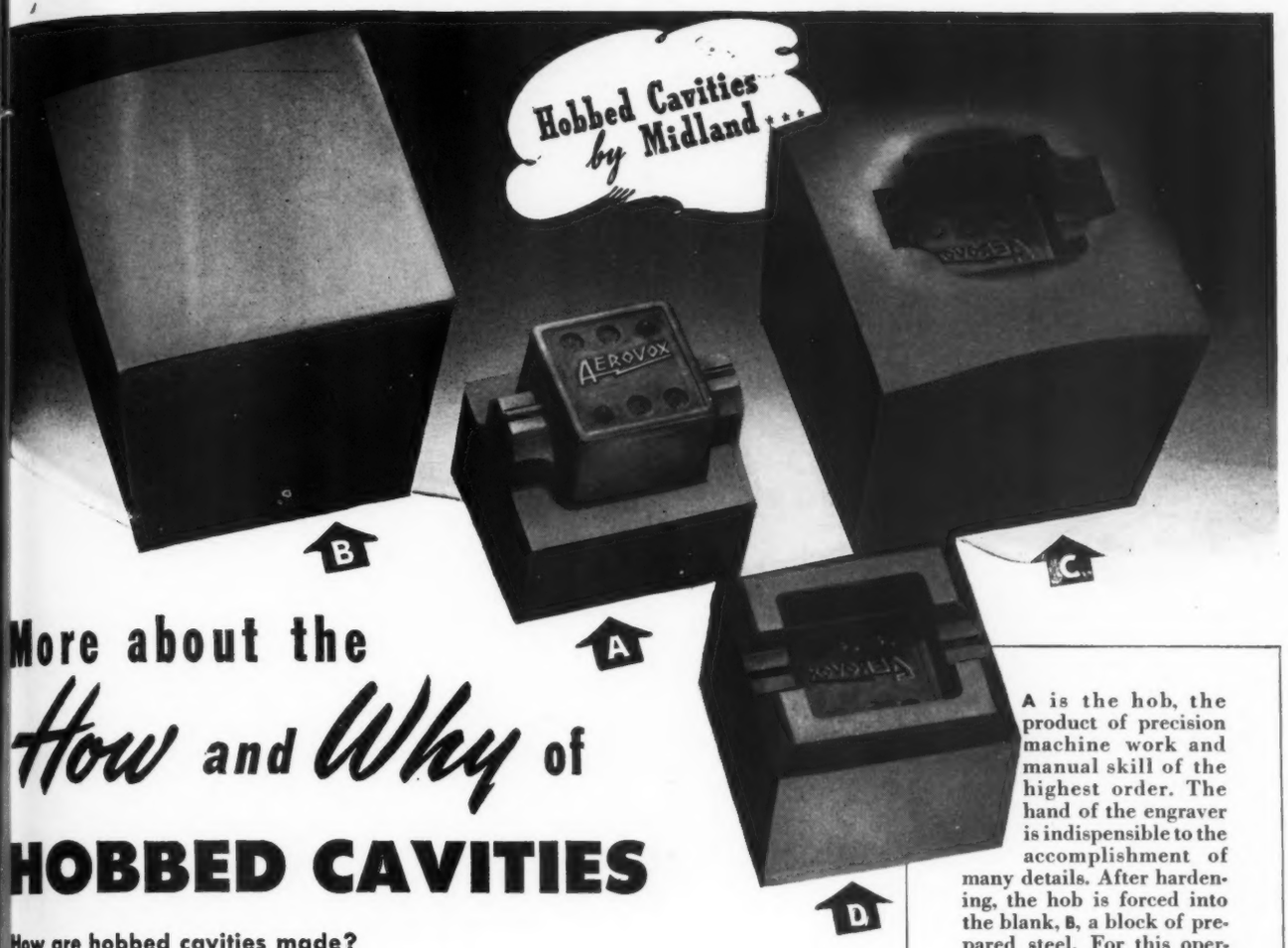
—To design new, better, war equipment

—To redesign for speedier production and assembly.

—To adapt alternate materials to your designs.

● The wide coverage of the advertising in PRODUCT ENGINEERING — materials, mechanical parts, finishes, fabrication methods — brings up-to-the-minute information and services to you, the design engineer. Advertising volume for the first 9 mo. of 1943 was 2221 pages, as compared with 1865 pages for the entire year of 1942.

● Editorial pages in this issue total 75, and include data on new methods, materials and mechanical parts that will help you reduce costs, speed production, and build more efficient machinery and equipment.



More about the *How and Why* of HOBBED CAVITIES

How are hobbed cavities made?
When should hobbed cavities be used?
What are their advantages?

● Clear answers to these questions will help to increase the general understanding and appreciation of the process, and explain why it is a specialty at Midland Die & Engraving Company. On multiple-cavity jobs, hobbing saves weeks or months of time and labor, and is the logical method of assuring absolutely uniform cavities. For many shapes it is the only practical way to sink the cavity in a one-piece mold.

The example illustrated above is from a mold holding nearly a hundred cavities. One hob was made; on it the engraver and die maker exercised their special skills in full measure. Sinking this hob in a series of blanks was a simple and rapid operation done almost entirely by machinery, using many tons of pressure, though requiring skill in controlling the flow of metal in a cold state.

Some of the deepest and most intricate hobbed cavities ever made, were the product of Midland, where both equipment and experience in this field are exceptional. We invite inquiries from manufacturers, molders and die-makers, on any phase of mold or die construction.

A is the hob, the product of precision machine work and manual skill of the highest order. The hand of the engraver is indispensible to the accomplishment of many details. After hardening, the hob is forced into the blank, **B**, a block of prepared steel. For this operation, pressures up to 3000 tons are available. The sinking may require two or more pressings, with the block annealed before each.

The cavity, **C**, as it comes from the press, is a perfect facsimile of the hob, in reverse. Excess metal is milled away, and the piece is carburized, giving a surface comparable to the finest tool steel. Finishing the cavity requires precision grinding on all surfaces which meet other parts in the final assembly. Because of the high polish given the hob, the cavity itself requires a minimum of hand polishing to produce a mirror surface, assuring a perfect surface on the molded parts.

D&E

MIDLAND DIE AND ENGRAVING COMPANY
1800 W. BERENICE AVENUE • • • CHICAGO, ILLINOIS
Makers of Plastic Molds • Die Cast Molds • Engraved Dies • Steel Stamps • Hobbings • Pantograph Engraving

The paper that hushed "studio noise"

A radio microphone is strictly impartial — it will pick up the "rattle" of script paper as well as the announcer's voice.

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1800 W. BERENICE AVENUE • • • CHICAGO, ILLINOIS
Makers of Plastic Molds • Die Cast Molds • Engraved Dies • Steel Stamps • Hobbings • Pantograph Engraving

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DAMN THE ~~TORPEDOES~~ FULL SPEED AHEAD!

Making only Mounted Wheels and small Grinding Wheels—maintaining highest quality in spite of large quantities and rush orders—shipping them promptly. ***This is our job, our battlefield.***

With full WPB approval, we stopped making all large size grinding wheels and fixed our sights on wheels *3" in diameter and under.*

We worked all around the clock, 24 hours a day, and in a short time were able to fill orders on time—And, our central location cuts time in transit. Today, there is no waiting. With the Army-Navy E at our masthead, we are going full speed ahead.

ARMY E NAVY

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To get acquainted with Chicago Wheels, let us send one postpaid. Tell us size wheel and material you wish to grind.

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Half a century of specialization has established our reputation as the Small Wheel People of the Abrasive Industry. You can bank on us.

AMERICA'S HEADQUARTERS FOR MOUNTED WHEELS SMALL GRINDING WHEELS

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☐ Send Test Wheel.

Size .....

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Name .....

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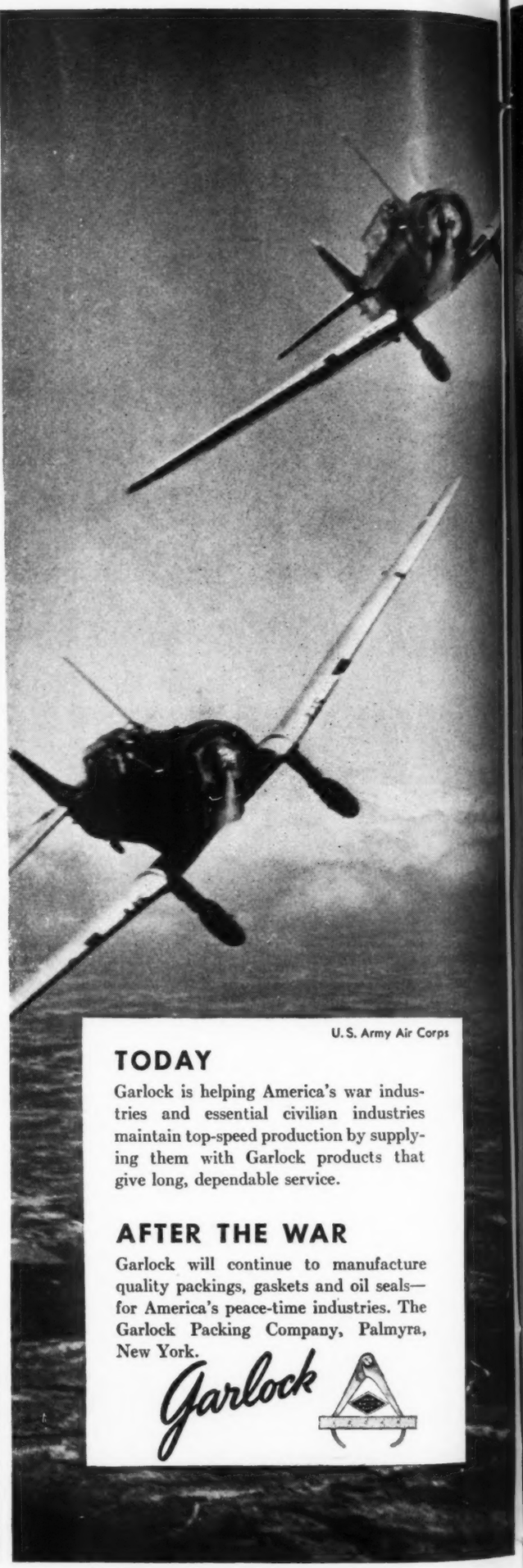

U.S. Army Air Corps

TODAY

Garlock is helping America's war industries and essential civilian industries maintain top-speed production by supplying them with Garlock products that give long, dependable service.

AFTER THE WAR

Garlock will continue to manufacture quality packings, gaskets and oil seals—for America's peace-time industries. The Garlock Packing Company, Palmyra, New York.

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FOR ACCURATE TEMPERATURE CONTROL
in all latitudes...
in all altitudes
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#1½ Blower reduces space requirements for heat dissipation. Unexcelled for applications in electronic equipment.
OUTPUT . . . 15 C.F.M. at 8000 R.P.M.
HOUSING . . . High impact plastic
WHEEL . . . Turbo type 1½" diameter
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Bulletin including complete performance specifications available on request.
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HE'S A FLYING GUY

Who's Flying High

This man was at Pearl Harbor. That day he never got his plane off the ground. A bomb got it first.

He fought against great odds for the next year or two. One plane against three . . . ten against forty. And he did all right, too.

Today those odds against him have been greatly reduced as planes in ever-mounting thousands roll off America's production lines. Acme men and women are happy that they've made some contribution to the plane this man flies and to the equipment he's got.

They are proud of the part they are playing in producing for victory, because whether it's patterns, dies, heat-treated aluminum castings, or specially engineered tools needed by war plants, Acme production is keyed to the slogan "Acme for Action."

ACME PATTERN & TOOL COMPANY, Inc.
DAYTON, OHIO

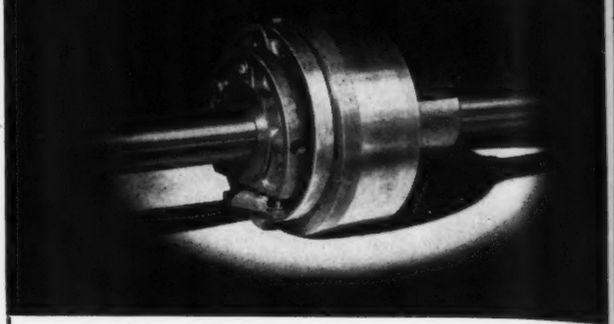
Heat-Treated Aluminum Castings—Patterns—Tools—Tool Designing—Production Processing

For VICTORY buy WAR BONDS and STAMPS

ARMY E NAVY

★ ★ ★ THE HILLIARD ★ ★ ★

SINGLE REVOLUTION *Clutch*



Wherever extremely accurate control of intermittent machine operation is essential the Hilliard Single Revolution Clutch is unequalled. Its accuracy has won for it the acceptance of Industry for cutting, punching and packaging operations.

★ WRITE TO-DAY!

For information that will help you to adapt this clutch to your needs.

THE HILLIARD CORPORATION
101 W. Fourth St.
ELMIRA, N. Y.

★ OVER-RUNNING ★ SLIP . . . CENTRIFUGAL ★ FRICTION

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DROP-FORGINGS

ANY SHAPE • ANY MATERIAL • COMPLETE FACILITIES
Write for Free Forging Data Folder. Helpful, Informative
J. H. WILLIAMS & CO., *"The Drop-Forging People"* BUFFALO, N.Y.

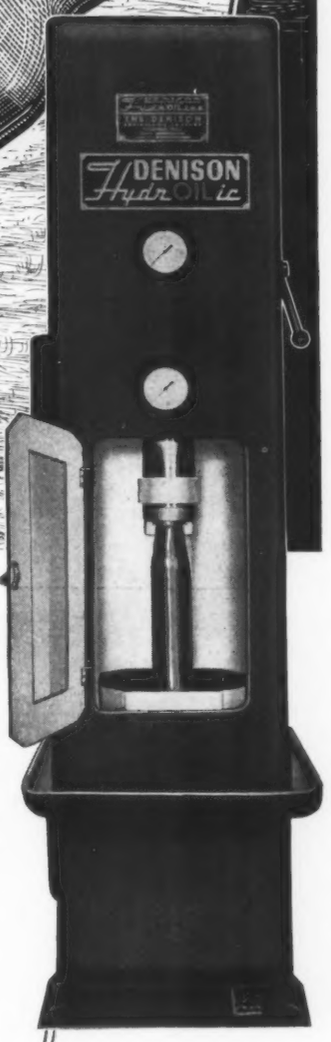
BEALL KANT-LINK SPRING WASHERS

KEEP BOLTED ASSEMBLIES *permanently* TIGHT

BEALL Spring Washers compensate for wear, bolt-stretch, corrosion and break-down of finish. They meet rigid Army, Navy and Air Corps specifications. Available in Carbon Steel, Stainless Steel, Phosphor Bronze, Everdur and Monel Metal. Finished in Cadmium Plate, Galvanized, Silver and Parkerized. IMMEDIATE SHIPMENT of all standard sizes.

WIRE US your requirements

BEALL TOOL CO. (Div. Hubbard & Co.)
EAST ALTON, ILLINOIS



. . . and that's exactly what this important piece of ordnance was supposed to do, if it wasn't "fit for action"! Tested under tons of water pressure, in the Denison Hydrostatic Test Press shown at right, it burst—thus preventing what may have been a deadly gun-accident had it reached the fighting front . . . Another of the many ways Denison oil-hydraulic equipment serves the nation today!

Think about it . . . Doesn't a press like this, with its HydrOILic fingertip control of pound-by-pound pressure, fit into your wartime production scheme, or your postwar plans? It could burst-test tubing of all kinds — ceramic, plastic or metal. It could easily and accurately test the impregnation qualities of hundreds of materials . . . could be used for production-line impregnation of small parts. It could burst or collapse-test small containers made of plastic, metal or glass. Porosity tests of innumerable materials could be effectively made through its close control of pressures from a few pounds to tons.

THE DENISON ENGINEERING COMPANY
1157 Dublin Road Columbus 16, Ohio

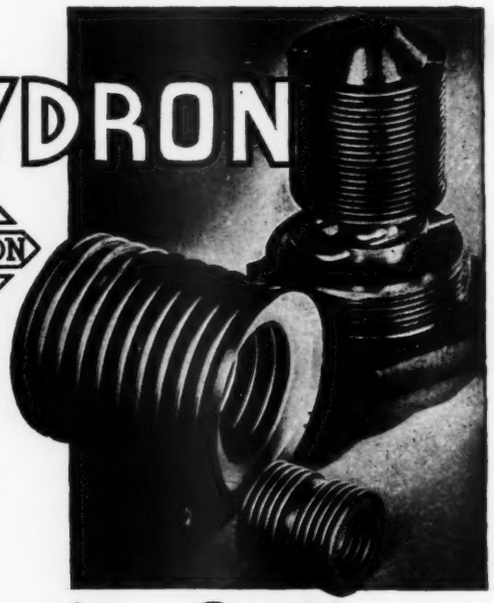
Today or Tomorrow

We're working 100% for Uncle Sam today. That means priorities are necessary for any HydrOILic equipment. If you have those priorities, we will gladly work with you now. If not, file this page in your postwar plans.

INDUSTRY'S NEW RIGHT HAND FOR POWER, SPEED and CONTROL

DENISON EQUIPMENT in APPLIED HydrOILics

HYDRON



HYDRON Metal Bellows

Metallic Bellows

We manufacture bellows and bellows assemblies ready for installation in steam traps, relief valves, temperature regulators, pressure regulators, air valves, and other automatic temperature and pressure controls. Complete engineering service.

CLIFFORD MANUFACTURING CO.

CHICAGO
221 N. LaSalle Street

564 East First Street
BOSTON, MASS.

DETROIT

SHIPPED AT PEACE-TIME SPEED

GILBARCO COOLANT PUMPS are made by one of the country's largest pump manufacturers for all machine operations. Rugged and durable, they are built for 24 hours a day service.

STANDARD MOTORS Pumps with motors for all regular voltages and cycles, two or three phase, shipped promptly.

SPECIAL MOTORS Facilities for winding motors for unusual electrical characteristics enable us to ship almost as promptly as standard units.

Write or wire for literature and prices

GILBERT & BARKER MFG. CO.
WEST SPRINGFIELD, MASS.

FABRICATORS OF PLATE AND SHEET STEEL

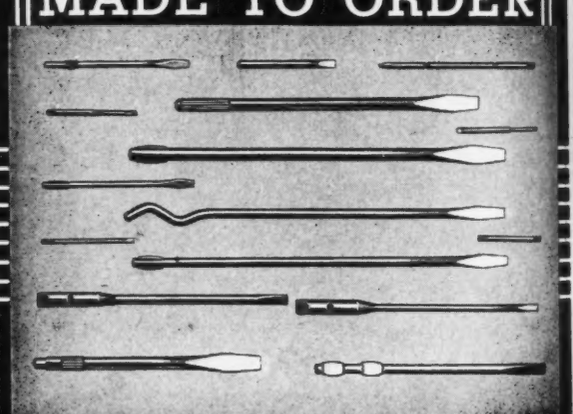
Manufacturers who need Fabricated Metal Products for Victory or for Post War development can look to Littleford for quality work. 63 years of fabricating experience. No matter how large or small the product may be, Littleford can follow specifications or help in the designing.

LITTLEFORD

BUY MORE BONDS

LITTLEFORD BROS., INC.
506 E. Pearl St., Cincinnati, Ohio

MADE TO ORDER



Screw driver blades to order for assembly in any type of handle, wooden, composition or plastic.

Points in either keystone or cabinet type. Edge of point carefully made and of uniform thickness.

Shanks are winged, fluted, formed or milled, as shown.

Blades furnished in plain finish, blued or nickle plated.

The Torrington Company
SPECIALTY DEP'T.
Torrington, Conn., U.S.A.

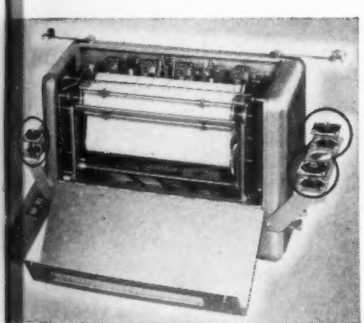
CONTROL VIBRATION...

Use

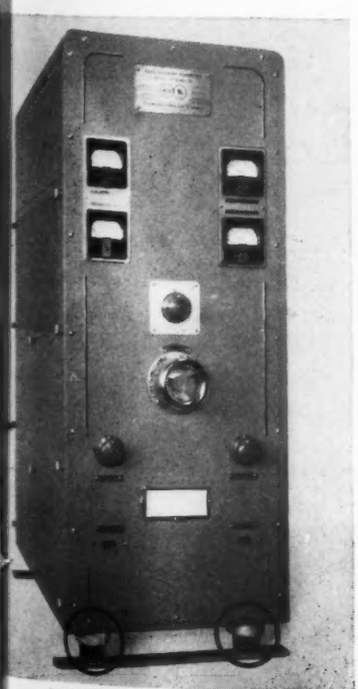
LORD
BONDED RUBBER
Shear Type
MOUNTINGS

- **PROLONG LIFE**
- **REDUCE MAINTENANCE**

For All Types of Electrical and Mechanical Equipment



FRIEZ FLIGHT ANALYZER



MARINE RADIO TRANSMITTER

VIBRATION is no longer a necessary evil; it can be controlled; its harmful effects can be minimized. Lord Mountings are designed for this purpose, whether the problem is one of isolating light, delicate equipment from surrounding vibratory forces, or controlling vibration emanating from heavy massive machinery.

There is a Lord Mounting to suit any combination of weight, frequency, deflection, and operating conditions. With full factual information on any problem, we can tell you how to properly mount any piece of equipment, to prolong its active life and reduce maintenance charges for your customers.

For complete information covering all Lord Mountings, including an engineering discussion on vibration control, write for bulletins 103 and 104, or call in a Lord Vibration Engineer for consultation on your vibration problems. There is no obligation.

Properly Installed LORD Mountings

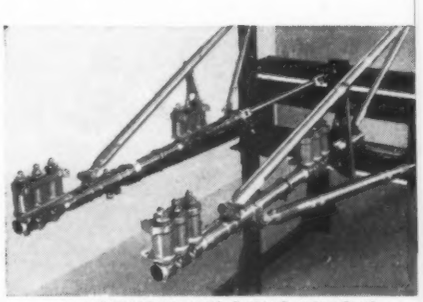
PROLONG EQUIPMENT LIFE by isolating vibration, which reduces metal fatigue and prevents mechanical failure.

INCREASE PRODUCTION by eliminating the necessity for close machining and precision alignment.

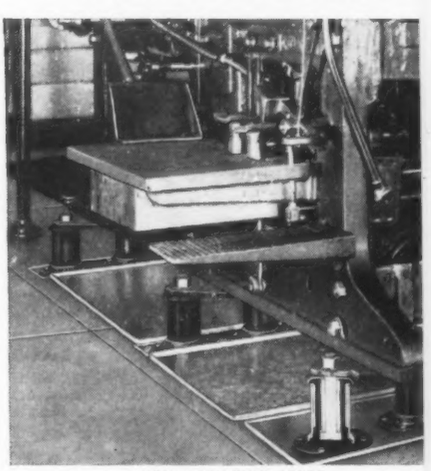
SAVE VITAL MATERIAL by reducing equipment weight; inertia masses of machinery bases can be reduced or eliminated.

INCREASE PERSONNEL EFFICIENCY by eliminating nerve wearing noise and vibration, translated through solid conduction.

LOWER MAINTENANCE COSTS by protecting equipment against sudden load shocks and stresses, thereby minimizing repair and replacement operations.



AIRCRAFT IN-LINE ENGINE MOUNTING



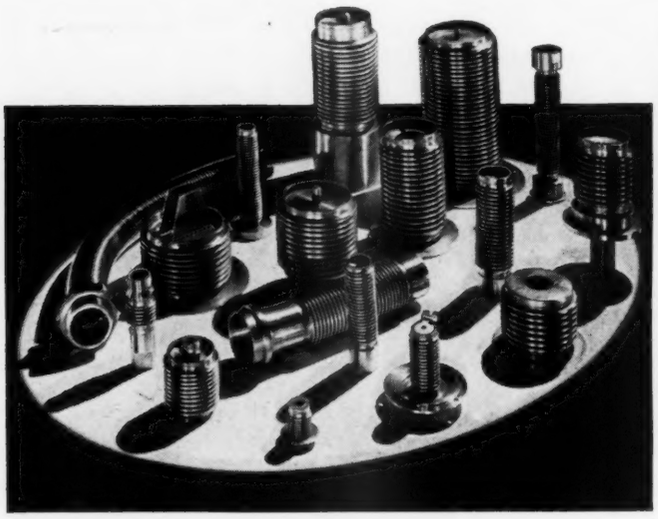
HEAVY PRINTING PRESS

IT TAKES RUBBER *In Shear* TO ABSORB VIBRATION

LORD MANUFACTURING COMPANY
ERIE, PENNSYLVANIA

SALES REPRESENTATIVES
NEW YORK - - 280 MADISON AVE.
CHICAGO - 520 N. MICHIGAN AVE.
DETROIT - - 7310 WOODWARD AVE.
BURBANK, CAL. - 245 E. OLIVE AVE.

Originators of Shear Type Bonded Rubber Mountings



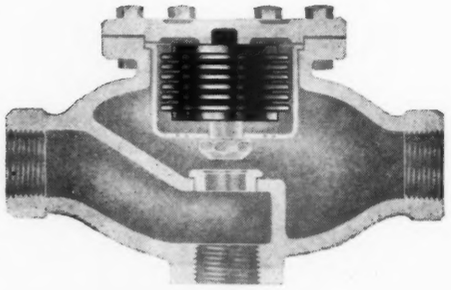
CMH

Stainless Steel Bellows

Wherever stainless steel's corrosion resistant qualities and temperature values are required in bellows service, CMH uni-metal **circular seam welded** assemblies are filling that need.

No Solder or Flux Required

Long lengths of CMH Bellows are standard production; strength is further enhanced with **multiple ply** assemblies when needed.



Ask for engineering recommendations on specific applications.

CHICAGO METAL HOSE CORPORATION

General Offices: MAYWOOD, ILLINOIS

Factories: Maywood and Elgin, Illinois

Immediate delivery...

BROWN

AIR REGULATORS

at 1/3 to 1/5 the usual cost!

Designed to meet U. S. Navy standards of accuracy and dependability! Provides working pressures from 0 to 140 lbs. Simple, trouble-free mechanism. Unaffected by oils and water. *Write for prices, details.*

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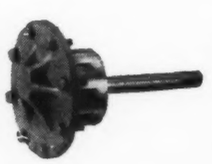
5718 Armitage Avenue • Chicago 39, Ill.

SPEEDY AIR VISES · COMPRESSORS · FILTERS · AIR GUNS

STRIPPED FOR ACTION

TUTHILL

"STRIPPED PUMPS" SAVE MATERIAL, SPACE AND MONEY . . . Build the pump directly into the design of your machine and save space, material and money. For this purpose, Tuthill provides positive-displacement, internal-gear rotary pumps in stripped form. Capacities from 1 to 50 g.p.m. for coolant, lubrication and liquid transfer service. Write for Tuthill Stripped Pump bulletin.



★ SERVING ARMY • NAVY • AIR FORCE MERCHANT MARINE

TUTHILL **TUTHILL PUMP COMPANY**
939 E. 95th St., Chicago 19, Ill.

GAZE ON A MIRACLE IN *Gear Production*

BOMBERS carrying bigger loads than freight cars! Fighters that can dive faster than sound travels! These are modern miracles of air warfare—miracles made possible by the giant Wasp Engines that power these planes.

And miracles beget miracles. For in these engines are gears of such extreme precision that their manufacture by any other method save exhausting hand labor, was long deemed impossible. Transforming these hand methods into mass production—turning out these high-precision gears by the hundreds of thousands needed for the world's largest air armada—was an achievement made possible by new manufacturing methods—new production techniques developed by Foote Bros.

These precision gears may well open the way to new miracles in the economical transmission of power when the war is won. For already on the boards of many American manufacturers are plans for machines that will utilize the type of precision gear Foote Bros. are producing for aircraft engines.

FOOTE BROS. GEAR AND MACHINE CORPORATION
5225 South Western Boulevard • Chicago, Ill.

FOOTE BROS.

Better Power Transmission Through Better Gears

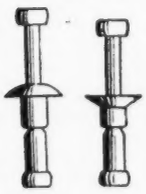
HOW TO HEAD A RIVET IN PLIABLE MATERIAL

CHERRY BLIND RIVETS

CHERRY BLIND RIVETS of the hollow type are shown above holding a rubber cleat to a rubber conveyor belt. Both hollow and self-plugging types of Cherry Rivets make ideal fasteners for pliable material because they are headed by means of a pulling force. There is no hammering on rivet heads—no bucking bar needed.

Application is faster than with conventional rivets and may be done with inexperienced labor.

There are undoubtedly many places where you too can use Cherry Rivets to save time, reduce costs and get a better job. Ideal for speeding up work on war jobs. Get the full story on Cherry Rivets now.



Self-plugging type with brazier and countersunk heads. Mandrel is pulled through rivet and permanently plugs it.

WRITE FOR HANDBOOK telling how to use Cherry Rivets. Address Department A-106, Cherry Rivet Company, 231 Winston Street, Los Angeles 13, California.

Cherry Rivets, their manufacture and application are covered by U. S. Patents issued and pending

Cherry Rivet
Company
LOS ANGELES, CALIFORNIA

FULLERGRIPT BRUSHES
Designed and Built for Every Machine Need

FULLERGRIPT BRUSHES
Standard Equipment for many machines in these industries:

TEXTILE MILLS
MEAT PACKING
FLOUR MILLS
BAKERY — CANDY
LEATHER FINISHING
RUBBER FINISHING
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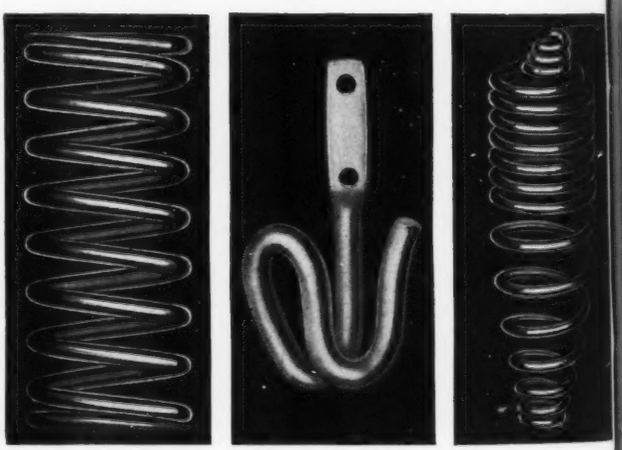
PACKAGING
LABELING

FULLERGRIPT made-to-order Brushes are designed for use as moving or stationary parts in machines requiring brushing operations, or for production work. Brush materials gripped in steel. Replacements with refills quickly made.

Our Engineers will work with you to fit brushes to machines in blue print stage, or to machines in production. Send prints and specifications for quotations.

THE FULLER BRUSH COMPANY
Industrial Division, Dept. 8C
3590 MAIN STREET • HARTFORD 2, CONN.

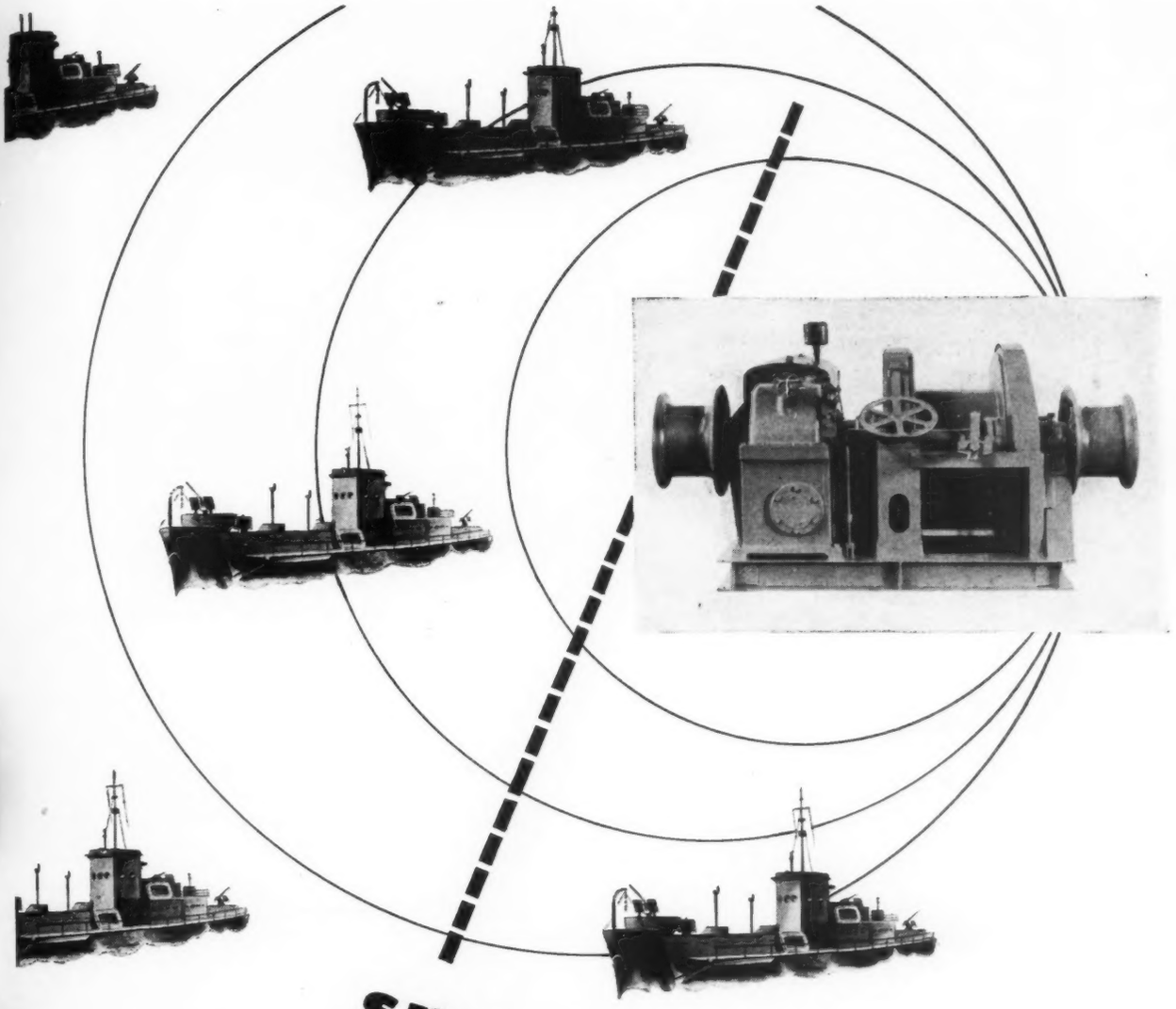
WAR JOB *Springs*



NEED SPRINGS *for* WAR JOBS?

Cuyahoga's broad experience in designing and manufacturing springs, wire parts and small stampings is available for direct war or sub-contractor requirements.

CUYAHOGA SPRING CO.
10251 Berea Road .... Cleveland O.



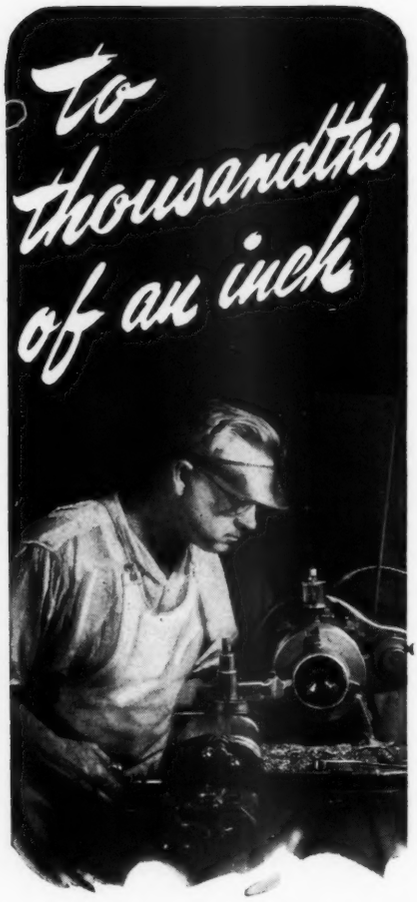
special delivery

The task of landing infantry on hostile shores—and getting them off in a hurry when the need arises—falls to the LCI's. Gasoline driven windlasses, like that pictured above, are on the LCI's that are hitting the enemy where it hurts most. These windlasses constitute just one of the many contributions to our Navy's fighting strength that Bayard is proud to make!

BAYARD

M. L. BAYARD & CO., INC. • ENGINEERS AND MACHINISTS PHILA., PA.

The second star of continued achievement has now been added to the Bayard Navy "E" Pennant.



DIE-CUTTING of Booth felt parts is a precision job . . . often to tolerances in thousandths of an inch. Every die in the vast Booth stock is accurate. Each Booth-designed machine has its skilled operator. To the controlled qualities in Booth "prescription" felts—made to suit your individual requirements—add precision cutting. Exact duplicating of any felt part, re-ordered after a lapse of time, is considered a feat. Booth does it consistently.

THE BOOTH FELT COMPANY
475 19th Street Brooklyn, N. Y.
736 Sherman Street Chicago, Ill.

APPLICATION CHART AND SAMPLE KIT . . . Contains swatches of S.A.E. felt types, with specification tables. Write for it. (No sales follow-up.)

2073

Booth
TRADE MARK

PRECISION CUT FELT PARTS

ANOTHER SPECIAL BY PROGRESSIVE

For special heads, threads, finishes, etc. — on fastenings of any metal or alloy adapted to cold-upset — depend on Progressive. 25,000,000 is our weekly output; customer satisfaction our daily achievement.

The PROGRESSIVE MFG. CO.
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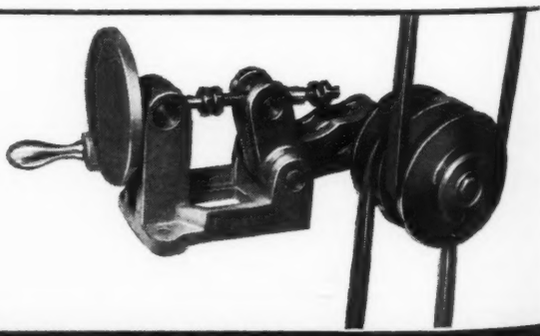
SPEEDMASTER

FOR INCREASED PRODUCTION

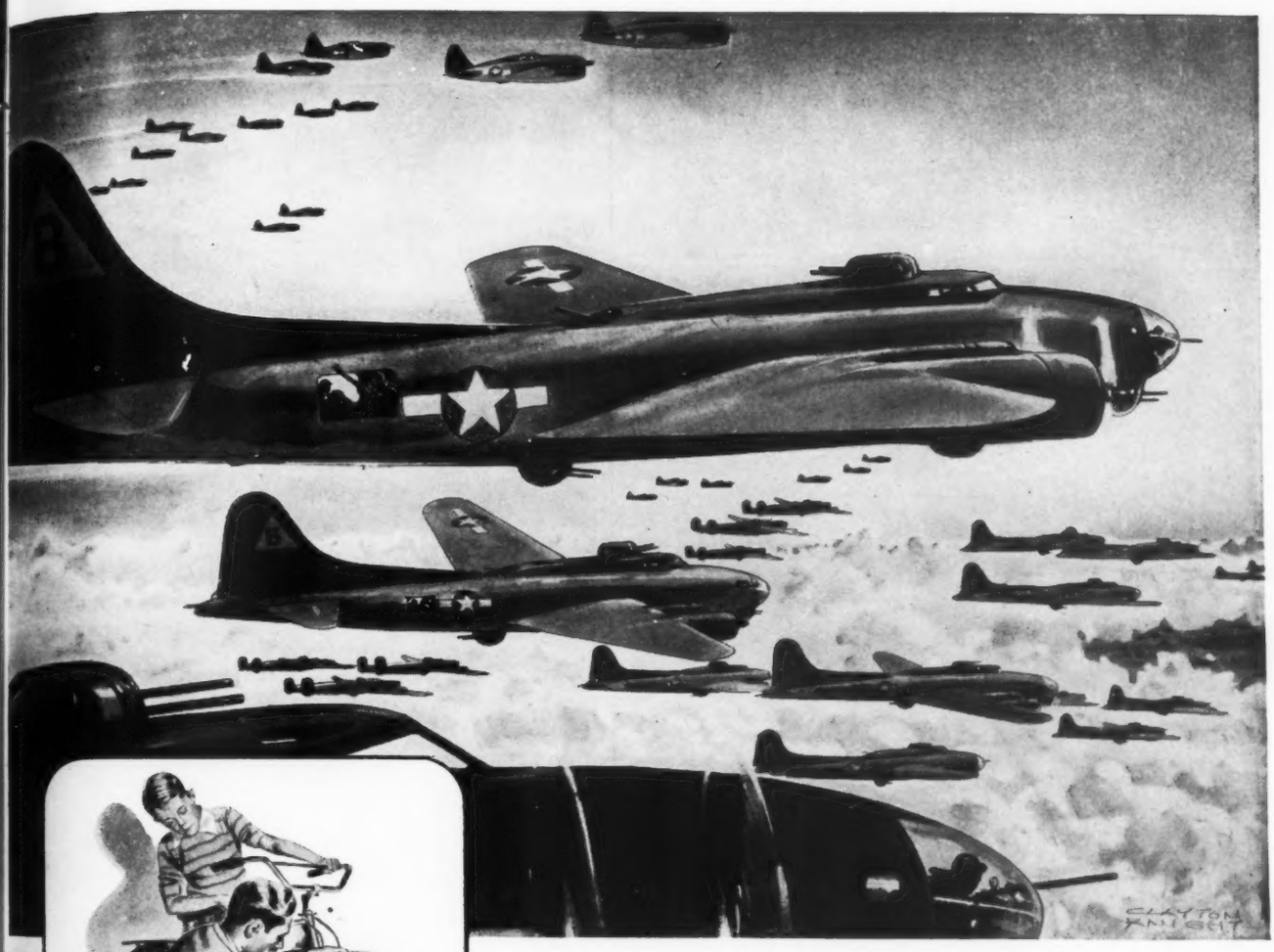
Step up the output of your machines by equipping each one with a Speedmaster, the compact Variable Speed Control that gives a versatile range of speeds, 6 to 1 ratio, one to suit every job in work.

A turn of the control instantly increases or decreases operating speed, without work stoppage. Free floating pulley aligns belts automatically and insures long belt life. 3 sizes, 9 types.

Consult our Engineering Dept. about adapting this modern speed control to your machines. Write for interesting Speedmaster manual.



THE SPEEDMASTER CO.
1213 THACKER STREET DES PLAINES, ILLINOIS



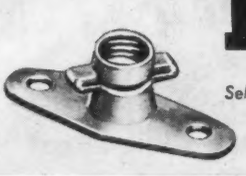
They Fly With Their Boots On—Farther

Boots All-Metal Self-Locking Nuts are lighter than any other similar fastenings. On a single Liberator or Flying Fortress they save up to 80 pounds. That's enough to enable one of these 4-engine giants to take along extra gallons of gasoline—or 200 additional rounds of .50 caliber machine gun ammunition. A little extra range or a few more bullets may be just what's needed to get a bomber home from a 2,000 mile raid over enemy territory.

In case you're wondering whether nuts as light as Boots can "take it," there is plenty of evidence to prove just how tough they really are. They withstand the corrosive action of oil, salt water and chemicals. No amount of plane vibration can loosen their grip. Boots Nuts can be used over and over again—literally "outlast the plane." In fact, today these nuts are worn by every type of U.S. aircraft. Yes, Boots Nuts meet the exacting specifications of all government aviation agencies.

Boots Will Eliminate This Chore After Victory

Often Bill's bike shakes and shimmys so badly that he can't ride it safely. Normal vibration loosens wheel nuts—probably every other nut too—so Dad has to get a wrench and tighten up the whole bike. But after the war, Bill will ride safer and Dad will be spared many a tightening-up session, because well-made bikes will wear Boots Self-Locking Nuts. Even severe vibration can't shake Boots Nuts loose. For safety's sake and to eliminate repairs caused by vibration-loosed connections, you will insist on products protected with Boots Self-Locking Nuts.

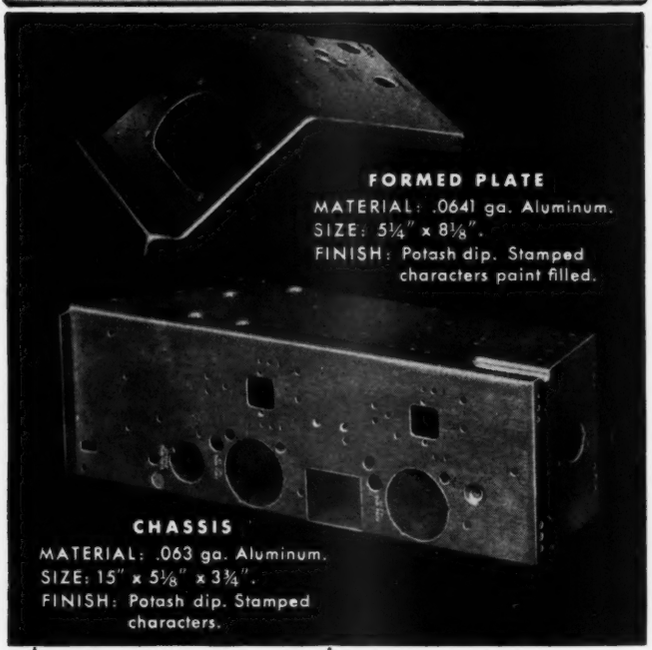


BOOTS

Self-Locking Nuts For Application In All Industries

BOOTS AIRCRAFT NUT CORPORATION ★ GENERAL OFFICES, NEW CANAAN, CONNECTICUT

Special Fabrications by DAHLSTROM


FORMED PLATE
MATERIAL: .0641 ga. Aluminum.
SIZE: 5¼" x 8⅛".
FINISH: Potash dip. Stamped characters paint filled.
CHASSIS
MATERIAL: .063 ga. Aluminum.
SIZE: 15" x 5⅛" x 3¾".
FINISH: Potash dip. Stamped characters.

Specialists in Metal Fabrication

•

DAHLSTROM is equipped for single unit or quantity production in any metals that can be cold-formed:

FINISHED METAL FABRICATION

UNFINISHED (rough) FABRICATION

LIGHT STAMPING and PUNCHING

FORMED, PRESSED SHAPES

COLD-ROLLED MOULDINGS and SHAPES

Write for the DAHLSTROM catalog of Metal Mouldings and Shapes.

In almost 40 years, we've learned a lot about fabricating hollow metal and sheet metal work in general. Today, this experience—plus our complete engineering, designing, tool and die, and manufacturing facilities — are being utilized by many war industries to produce the equipment needed by our armed forces.

In your post-war planning, we suggest that you consider Dahlstrom's facilities and experience in designing, fabricating, finishing and assembling metal parts.

We, too, are looking forward to the day when we can again apply our skill to peacetime products.

ARMY E NAVY

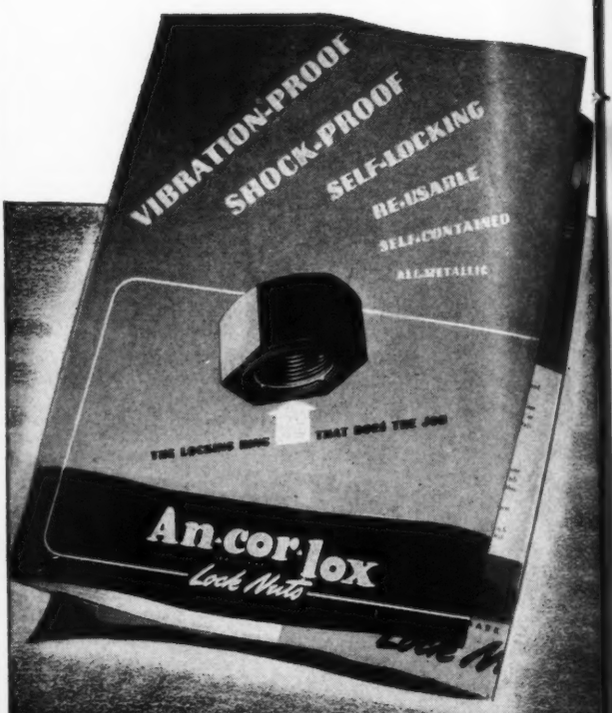
MOULDINGS DAHLSTROM CABINETS

METAL SPECIALTIES DIVISION

DAHLSTROM

METALLIC DOOR COMPANY

Sales Offices: JAMESTOWN, NEW YORK



Combines all significant lock-nut advantages!

READ THE STORY of this advanced nut locking principle. • An-cor-lox lock nuts (patented) are helping many a wartime production, service and maintenance job. • Locking security; quick, simple installation; wide adaptability; An-cor-lox provides them all.

Write for the An-cor-lox bulletin —and your An-cor-lox sample. Demonstrate for yourself.

An-cor-lox

TRADE-MARK REG

Lock Nuts

An-cor-lox Division

LAMINATED SHIM COMPANY

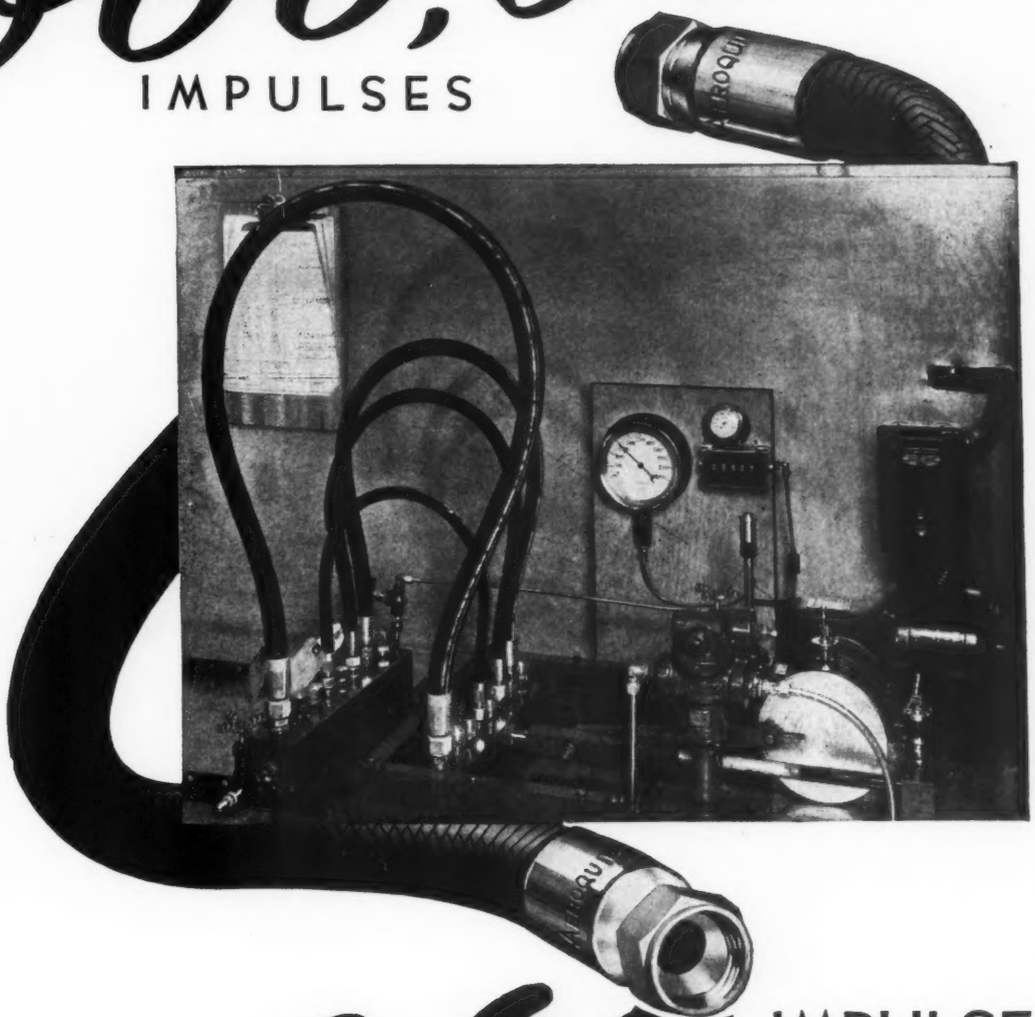
Incorporated

63 Union Street • Glenbrook, Conn.

HOW

1,000,000

IMPULSES



ON

100,000

IMPULSE TESTS

PROVES THE STRENGTH OF

AEROQUIP

HOSE LINES WITH DETACHABLE RE-USABLE FITTINGS

On this testing machine in Aeroquip laboratories, where hose lines and fittings are given 100,000-impulse tests at above-normal pressures—Aeroquip lines are part of the machine's equipment.

In running a series of tests, these Aeroquip lines on the machine itself take a million and more impulses as routine work—proof in plenty.

West Coast Office—
L. W. Pickens
1709 West Eighth St., Los Angeles, Calif.

Eastern Representative—
J. Henry Reisner,
Hagerstown, Md.

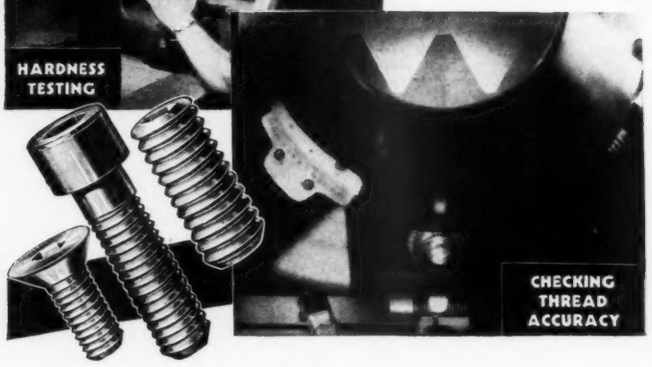
Canadian Representative—
Prenco Progress & Engineering Corp.,
72—74 Stafford St., Toronto, Canada

AEROQUIP CORPORATION
JACKSON, MICHIGAN, U. S. A.

BACK THE ATTACK
BUY WAR BONDS

Gunning for flaws in the defense

ALLEN Screws are laboratory tested for tensile strength, for yield point, elongation, reduction of area, Izod impact and Rockwell hardness. Threads are microscopically checked under the Comparator.

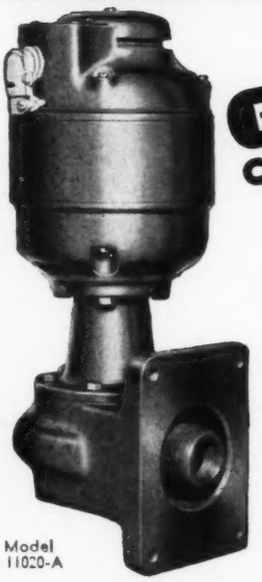


ALLEN technicians at testing machines are gunning for flaws all the time. Flaws that could weaken our defense by failure of a fastening, a part, a vital machine tool or desperately needed weapon. . . Imperfect "Allens" are found only in the laboratory; the *perfect* screws are found in the stocks of our Distributors — who exclusively sell them and service your needs. The Allen Manufacturing Company, Hartford, Conn.

ALLENS

NO CLOGGING

with **GUSHER COOLANT PUMPS**



Model 11020-A

Grit and chips that become mixed with the coolant pass through a Gusher Pump without doing the least harm. No packing glands and no metal-to-metal contacts make this possible without auxiliary strainers. There are many other outstanding features that make Gusher Coolant Pumps superior. There is a type and size for your needs.

Write for complete catalogue

THE RUTHMAN MACHINERY CO.
1813 READING ROAD CINCINNATI, OHIO
LARGEST EXCLUSIVE BUILDERS OF COOLANT PUMPS

DESIGN FOR
FASTER PRODUCTION
SPECIFY *Hartford* PRECISION BALLS

CHROME ALLOY
CARBON STEEL
STAINLESS STEEL
BRONZE
K-MONEL
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DRILLED BALLS
to specifications

Precision balls to meet every industrial requirement. Wear resistant...corrosion resistant...heat resistant. Our Engineering Department will be glad to make recommendations. Write today.

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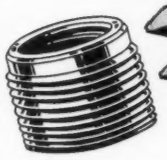
NEW YORK OFFICE MURRAY HILL 6-1923 EXPORT OFFICE: NEW YORK PHONE: PENNSYLVANIA 6-2078 CHICAGO OFFICE HAYMARKET 8871

"Heli-Coil" SCREW THREAD INSERTS

SAVINGS PLUS!

THE NEW WIRE INSERT

The "Heli-Coil" Bushing of stainless steel or phosphor bronze wire engages screw threads of the American National System. Protects tapped threads in light metals and plastics against abrasion, seizing or galling.



THE OLD HEAVY BUSHING The solid screw bushing is heavy and bulky. It, therefore, tends to restrict design. Internal and external threads are sometimes not concentric.

Aircraft engine builders and many other manufacturers save valuable man-hours through the use of "Heli-Coil" Screw Thread Inserts in three ways:

1. **They can be installed in one-quarter the time required for solid screw bushings.**
2. **They speed up maintenance, because they can be removed and replaced quickly in the field.**
3. **They can be manufactured four times as fast as solid bushings.**

"Heli-Coil" Inserts provide a quick, simple and inexpensive method of protecting tapped threads in aluminum, magnesium and other materials, against abrasion, stripping, seizing or galling. They also render important service in salvaging parts containing tapped threads that have stripped or worn oversize.

Send for Bulletins 237 and 238.

WITH "Heli-Coil" INSERTS YOU SAVE . .

TIME

Can be installed with simple hand or power tools in one-fourth the time required for solid screw bushings.

WEIGHT

Weighs one-fifth as much as the screw bushing of the same diameter.

SPACE

Occupies less than half as much cross sectional area as solid bushing, permitting more latitude in design.

METAL

Made from precision-shaped wire with no waste, requires about one-tenth as much metal as solid bushing made from bar stock.

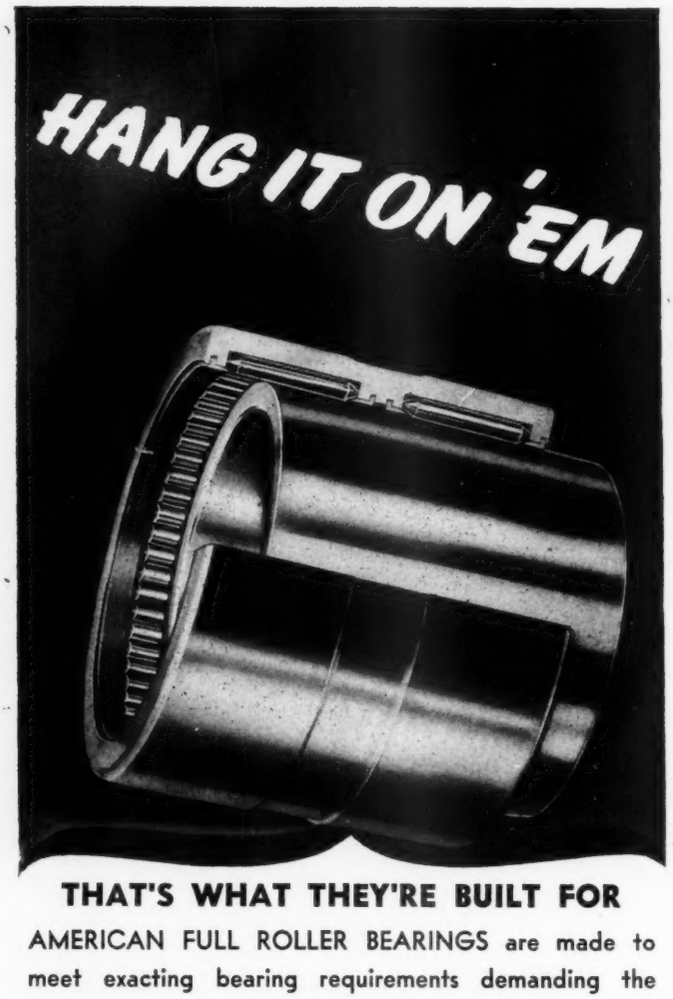
THE SCREW SYSTEM WITH THE ANTI-FRICTION THREAD LINING.

U. S. and Foreign Patents Issued and Pending.

AERO-THREAD

AIRCRAFT SCREW PRODUCTS COMPANY, INC.

47-23 35th STREET • LONG ISLAND CITY, 1, N.Y.



THAT'S WHAT THEY'RE BUILT FOR

AMERICAN FULL ROLLER BEARINGS are made to meet exacting bearing requirements demanding the utmost in strength, durability and smooth, continuous performance under gruelling and abusive operating conditions. AMERICAN FULL ROLLER BEARINGS are carefully engineered, service-proven, time-tested. They are specially designed for extra heavy duty service and guaranteed to give flawless, trouble-free performance under the most severe strains and stresses encountered in the operation of modern heavy industrial machinery and equipment. Because they are built to outlast the equipment itself, few AMERICANS have ever failed in service.

Consult AMERICAN engineers on your next full-roller application.

AMERICAN ROLLER BEARING COMPANY

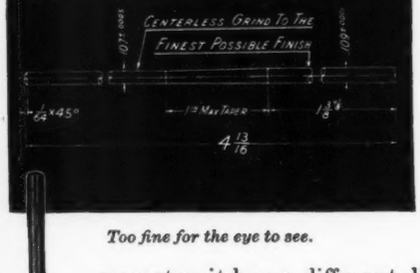
Pittsburgh Pennsylvania

Pacific Coast Office: 1718 S. Flower St., Los Angeles, California

AMERICAN HEAVY-DUTY ROLLER BEARINGS

PRECISION PARTS

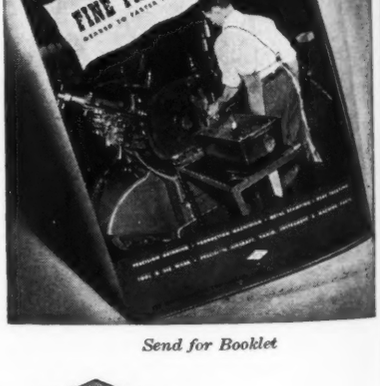
AS THOUSANDTHS SHEER



Too fine for the eye to see.

This finely machined, pressure-tight shaft is for a delicate instrument of war. To the eye, it is just a plain steel shaft. To the micrometer, it has a different diameter at each end, with a gradual taper in between. The difference in diameters is only .002" with a total tolerance of .0002" on the large diameter. Each shaft must be heat-treated before grinding. It must be kept straight, not varying more than .0005" in all its length, and not more than .0001" for any one-inch unit of length.

Ace, with modern heat-treating and centerless grinding methods, is turning them out by the thousands. Meeting these war-time demands for unbelievable accuracy, on a mass-production basis, has developed Ace ingenuity. Ace can therefore offer manufacturers many advantages in the profitable post-war markets. Here under one roof is a source of supply for small parts or assemblies which call for stamping, machining, heat-treating, or grinding. If you are thinking in terms of present production, we have capacity available from time to time. If you are planning for the future, let's talk it over now.



Send for Booklet

ACE MANUFACTURING CORPORATION

for Precision Parts

1245 E. ERIE AVE., PHILADELPHIA 24, PA.

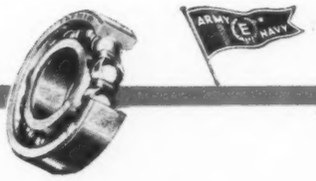
Triple Trouble ON THE WAY!

Photo, courtesy Lockheed Aircraft Corp.

Lockheed P-38 Lightnings spelled such trouble that the enemy aptly renamed them "Fork-tailed Devils." Primarily fighters, they raise additional hell as bombers, escorts, tank-busters and reconnaissance planes. Swaths of smashed Axis planes with a suitable garnish of blasted ground installations testify to the P-38's battle-ability.

Weighing seven tons, heavily armored and whooping along at 400 m.p.h. plus, these Lightnings might seem too much for one pilot to handle. But, handle it he does, and to tremendous advantage. The designers saw to that. Not the least of aids to maneuverability they included are Fafnir Aircraft Ball Bearings on the controls!

Combat equipment . . . planes, ships, tanks, gun mounts, all types of mechanical equipment . . . is taking Fafnir Ball Bearings by the millions. Others are going into the machines that turn out this fighting equipment. "On duty" twenty-four hours a day, both at home and abroad, Fafnirs are setting performance records which promise much for the troublefree, frictionless operation of future peace time products. The Fafnir Bearing Company, New Britain, Connecticut.



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BALL BEARINGS

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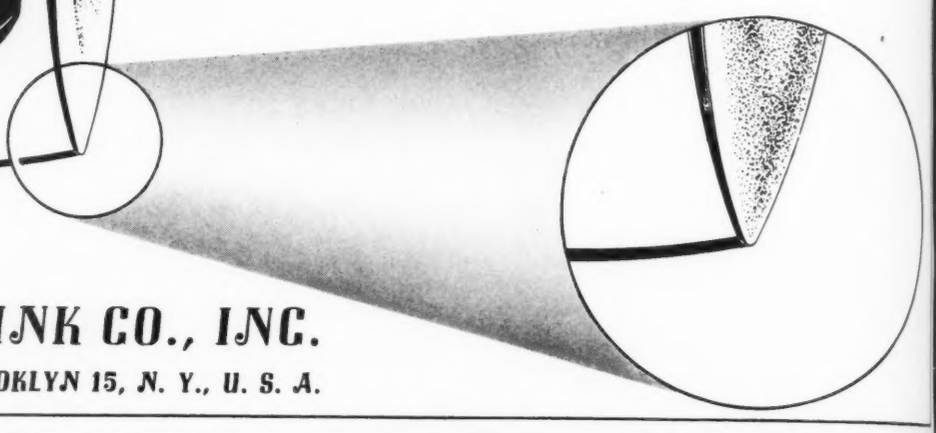
Make all your blue prints sharp and clear by using Higgins American India Ink for final tracings. No other ink or method can match Higgins for precise results . . . for *real* saving of time all along the line. More Higgins Drawing Ink is being used for final tracings than ever before because precise performance in the drafting room means hours saved in the production department.



HIGGINS *INK CO., INC.*

271 NINTH STREET, BROOKLYN 15, N. Y., U. S. A.

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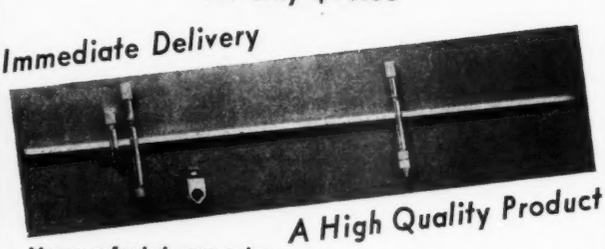
a new, precision BEAM COMPASS

for only $10.00

Immediate Delivery



A High Quality Product

Money refunded upon return of Beam Compass

Made in U.S.A.

Note these Important Features

- . . . micrometer adjustment for precise work
- . . . no deep holes to mar drawing; replaceable phonograph needle may be adjusted to any suitable length
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- . . . chuck type lead holder, holds standard size leads
- . . . 18-inch bar, precision machined to 3/16" square; other lengths available on request at slight additional cost
- . . . can be used as a T-square by sliding off pencil attachment
- . . . can be used as a gauge for laying out guide lines and borders
- . . . furnished with clip for holding ruling pen, pencil or scriber, which can be held anywhere on bar.
- . . . stencil cutting head, scriber, ruling pen and other special attachments available at slight additional cost.

ORDER NOW—USE COUPON

MARK SPECIALTY CO.,
406 Temple Bldg., Rochester, N. Y.

Enclosed is $..... (check—money order) for ..... (quantity) MARK BEAM COMPASS(ES). Please ship to:

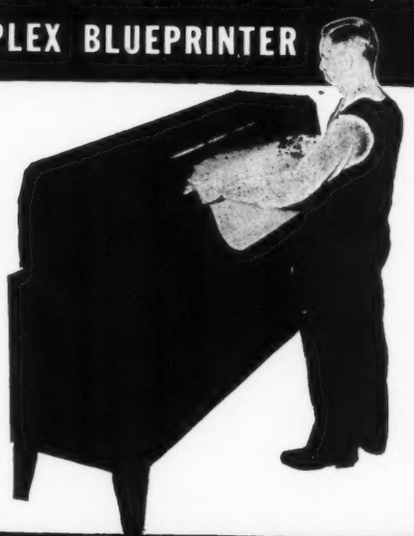
Name.....

Company.....

Position.....

Address.....

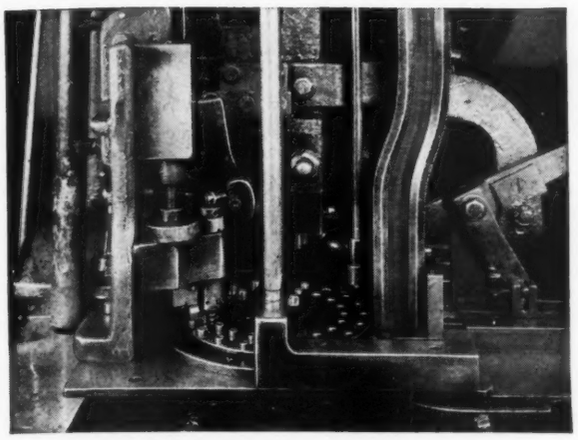
SAVE TIME WITH THIS FAST, PORTABLE SIMPLEX BLUEPRINTER



If your production is held up waiting for blueprints from outside firms, then a Wickes Simplex Portable Blueprinter will solve your problem in a hurry. This speedy machine processes up to 48" per minute with a maximum width of 42". For Blueprints, Van Dykes or other special developing processes. Mercury vapor tube heats up in 55 seconds. Requires no experience—your office girl can operate. Low initial cost. Uses a minimum of electricity. Prints sheets or continuous rolls. Requires very little space. Write for complete information to:

WICKES BROTHERS • SAGINAW, MICHIGAN
510 NORTH WATER STREET

better Methods that supplant hand labor



A locating device that turns bushing joints away from the bearing point as chain belts are assembled.

It has been estimated that the power used in machinery produces twelve times as much as *all* human labor could produce without it. At Baldwin-Duckworth you will find many machines that supplant hand labor, and at the same time provide *better* chain belt drives. One of them is this locating device. Attached to an assembly press it automatically turns bushings so that joints are away from the bearing point—resulting in an improved chain belt.

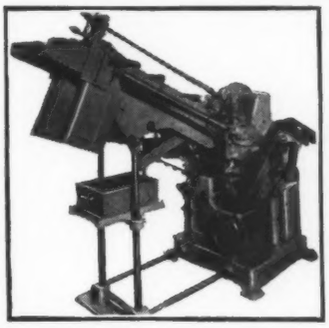
better Drives with Baldwin Roller Chain Belts

The use of Baldwin roller chain belts simplifies and improves the design of many machines. They absorb shock loading without measurable loss of power—transmit exact speed ratios for accurate timing—operate at virtual 100% efficiency.

The Baldwin catalog gives you data on standard chain belt application. For specialized applications on any machine you may be converting, designing or redesigning, a Baldwin man will gladly counsel you.

BALDWIN-DUCKWORTH Division of Chain Belt Company, 321 Plainfield Street, Springfield, Mass.

EXAMPLE



This clip loader for the famous Garand rifle is an important behind-the-lines war machine. Baldwin Roller Chain Belts give it:

1. Split-second timing
2. Smooth, jerk-free operation
3. Virtually 100% efficiency

IT'S BALDWIN-EQUIPPED

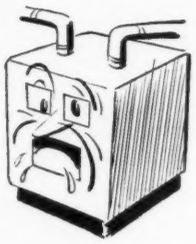
better Drives through better Methods

BALDWIN

ROLLER CHAIN BELTS

FUEL OIL SHORTAGE?

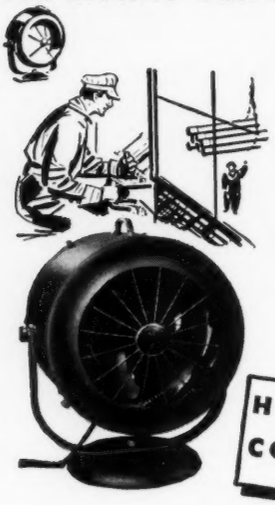
SOLVE THE PROBLEM WITH *Electric Heat*



Don't let possible shortages of fuels for heating threaten production. Electric heaters can help solve many heating headaches . . . quickly, easily, economically.

Westinghouse Large-Capacity All-Electric Fan-Type Dual-Purpose

UNIT HEATERS

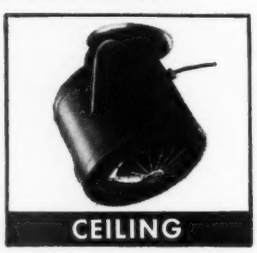


For office, shop, crane cabs, control boards, operating stations, assembly lines, shop offices, receiving and shipping rooms, unloading platforms.

In winter, these heaters deliver a large volume of clean heated air—quickly, and economically. In summer, they can be operated as large-volume electric fans, with heating elements turned off.

HEATS IN WINTER
COOLS IN SUMMER

MOUNTABLE ANYWHERE



Large swivel permits heater to be pointed in any direction, regardless of how it is mounted. Other features include: Temperature limit switch to protect against overheating; drilled base for easy mounting; attractive finish; sealed-in Corox heating units; wide fan blades; heavy-duty Westinghouse fan motor.

Sizes available: 2, 3 kw for both 115 and 230 volts a-c; and 4, 5, and 7½ kw for 230 volts only.

For complete information, call your Westinghouse office or write for Catalog 28-000, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., Dept. 7-N. J-10249

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PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

EXPERIMENTAL MODELS
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SPECIAL MACHINERY
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NO-INK Drawing Board TOP

Adopted as Standard By Major Industries

RE-SURFACE *Worn Boards. Modernize New Boards.*

PRECISION-IZE *Pencil Drawings for Perfect Prints.*

RELIEVE *Shortages of Men and Materials.*

SPEED *Production, Yet Cut Costs.*

Resilient drawing surface produces a sharp, opaque stroke in the drawing—results in perfect prints—makes inking unnecessary. The most perfect, most delightful surface to work on.

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Users are reordering in quantity. Over 25,000 NO-INK Drawing Board Tops already in use, saving man-hours, speeding production, renewing discarded boards, modernizing new boards. Costs so little.

We cut Tops to exact board size, no matter how large or how small. Attached by anybody in 10 minutes, ready for immediate use. Economize, modernize your drafting procedure. Write for catalog, prices and trial offer.

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Where to Use SYLPHON BELLOWS

The answer to countless design problems is the Sylphon Seamless Metal Bellows. In Thermostat assemblies, for instance, this amazing Sylphon Bellows helps solve the problems of temperature control in internal combustion engines, diesels, refrigeration and air conditioning, heating and ventilating, and many phases of industrial processing.

As highly efficient diaphragms used to convert pressure effects into controlled movement in instruments, appliances and machines of various types . . . as flexible seals, expansion chambers, rotating shaft seals, packless glands and for endless similar purposes, the Sylphon Seamless Metal Bellows is constantly replacing less durable, less dependable materials in the products of leading manufacturers.

Sylphon Bellows were pioneered 40 years ago by The Fulton Sylphon Co. And they have been first choice of American Industry ever since. Write today for Bulletin TP-535 which offers many suggestions for the designing engineer.

ARMY E NAVY

THE FULTON SYLPHON CO.
KNOXVILLE, TENNESSEE

Temperature Controls . . . Bellows . . . Bellows Assemblies

Warm-ups

FOR "FROZEN" MOTORS AND MEN

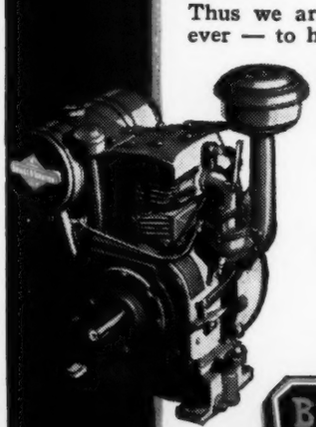
In bleak and frigid Northlands, air crews use unit heaters, powered by gasoline engines; to pre-heat motors, and other vital units of the plane — to prevent damage, and speed-up preparations for the take-off. One more front-line duty for the hundreds of thousands of dependable, instant-starting Briggs & Stratton 4-cycle engines serving our armed forces in hundreds of special and standard applications.

THE war's unprecedented demands have given us the opportunity to successfully meet a double challenge. ONE — to set new all-time records for production. TWO—to constantly maintain, even under wartime stresses, Briggs & Stratton high standards of quality, rugged dependability, precision manufacture and economical performance.

Thus we are better prepared than ever — to help on your present war needs or your postwar planning — and to keep up the Briggs & Stratton tradition as builders of "the world's finest air-cooled gasoline engines."

"It's powered right — when it's powered by Briggs & Stratton."

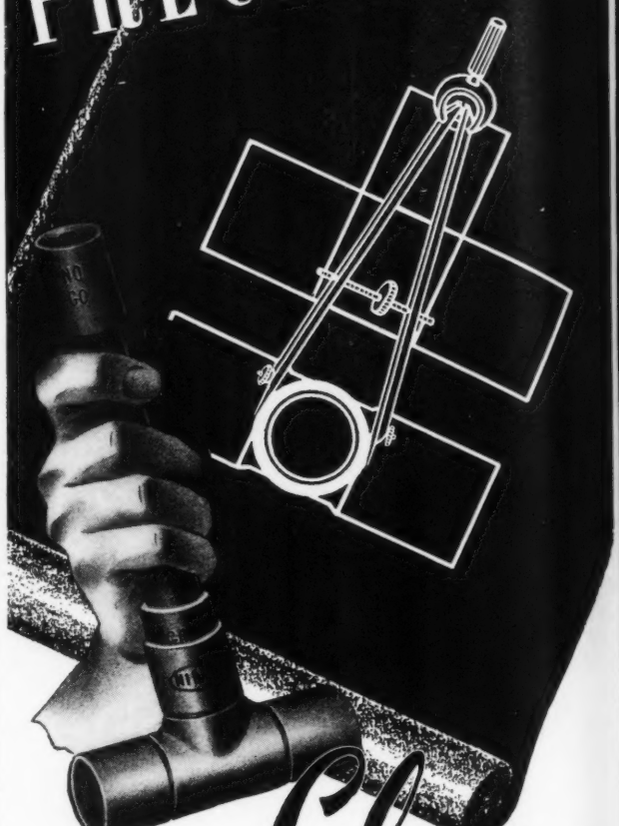
BRIGGS & STRATTON CORP.
MILWAUKEE 1, WIS., U. S. A.



4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES

BACK THE ATTACK
BUY WAR BONDS

PRECISION



Close

TOLERANCES

REMEMBER NIBCO WROT and Cast Fittings and Valves or special tubular parts of copper, aluminum or stainless steel when designing new equipment for low production cost. Special processes of manufacture make NIBCO WROT Fittings perfect in formation so that alignment is quick and easy. The use of individual "go" and "no go" plug gauge tests maintains close tolerances positively. It's a pleasure to use NIBCO Fittings . . . you can always depend on their quality and accuracy.

NIBCO WROT *Fittings*

NORTHERN INDIANA BRASS CO.
ELKHART, INDIANA
VALVES AND FITTINGS SINCE 1904

PEAK PRODUCTION SPEEDS THROUGH FINGER-TIP CONTROL

with these

WORTHINGTON ALLSPEED DRIVE FEATURES

- **16:1 RATIO (FROM ONE-EIGHTH MOTOR SPEED TO TWICE MOTOR SPEED)**—For all speeds for all needs.
- **THE ONLY DRIVE WITH AUTOMATIC POSITIVE BELT TENSIONING** — No springs. Assurance of smoother overall operating efficiency.
- **INSTANTANEOUS AND SMOOTH STEPLESS CONTROL**—Minimum through maximum speeds with a "finger-tip touch" while unit is in operation.
- **SINGLE-UNIT CONSTRUCTION . . . MORE COMPACT THAN ANY DRIVE IN ITS FIELD**—Can be installed in any position. Applicable to any machine . . . new or old. Easily accessible.
- **SIMPLICITY OF DESIGN**—Minimum working parts . . . no springs . . . trouble-free operation.
- **STURDY CONSTRUCTION . . . CONSERVATIVELY RATED**—Oversize retainer type ball bearings.
- **LOW MAINTENANCE COST**—Belts removed easily and quickly without dismantling unit.
- **AVAILABLE FROM STOCK**—Arrange for a demonstration today by writing the authorized WORTHINGTON ALLSPEED DRIVE DEALER in your area, or the nearest Worthington District Office.

MODEL A, ⅓ to ¾ H.P.

Designed specifically to speed up war production by finding the peak production speed of any productive unit.

THE WORTHINGTON ALLSPEED DRIVE

has been thoroughly job tested on many applications. It has proved its efficiency and stamina on a wide variety of work, including the finest precision jobs.

Reports from plant engineers and time study men show an increase in production ranging from 25% to 200%.

The Worthington Allspeed Drive will also play an important part in your training of inexperienced help by allowing you to increase the speed of the driven unit to parallel the growing experience of the operator . . . for maximum production with minimum spoilage.

MVS-18

WORTHINGTON ALLSPEED DRIVE

WORTHINGTON PUMP AND MACHINERY CORPORATION • GENERAL OFFICES: HARRISON, N. J.

"Peace On Earth..."

These words will not always be as empty as they may sound this Christmas! One day they will again assume their full significance. And with that day will come all those fruits of peace for which the world now yearns. And just as the 4-plant facilities of The Weatherhead Company helped American industry build products like the car, the airplane and the refrigerator in the past, in tomorrow's world we will be fully prepared to help you build your post-war products.

Look Ahead with

Weatherhead

THE WEATHERHEAD CO., CLEVELAND, OHIO

Manufacturers of vital parts for the automotive, aviation, refrigeration and other key industries.

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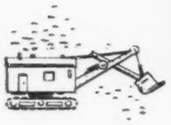
AIR!

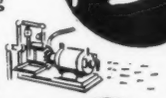
Coming into its Own for Power



Shown here are a few of the many types of units which utilize Gast air motors, compressors or vacuum pumps.

Some of these applications, as well as many others, are Gast developments . . . the direct result of the manufacturer bringing his problem to us.

Pressure



Wartime development of pneumatic equipment suggests that you may solve your problem with air power if you will get in touch with us.

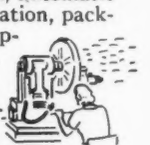
and

At your service are over 20 years of experience in designing, building and engineering special rotary air pumps and motors for standard equipment on hundreds of different machines.

This experience covers practically the entire field of airpressure and vacuum . . .

Vacuum

such uses as VACUUM for priming water pumps, automatic machinery, filtration, packaging, de-airing, evaporation, chucks, etc. . . . PRESSURE for gas generation, spraying, atomizing, automatic machinery, pneumatic controls, dusting, aerating, etc. . . . AIR MOTORS, for explosion proof requirements, variable speed mixers, etc.



Write for recommendations regarding most suitable type of air pump, motor or compressor . . . and complete data on the rotary principle that makes Gast units lower in cost, economical in operation, light weight, and extremely compact.

Address: **GAST MFG. CO., Dept. C**
Benton Harbor, Michigan

GAST

AIR MOTORS COMPRESSORS VACUUM PUMPS

Miniature of large May Oil Burner 30"x 45" poster appearing nationally on Subway platforms and in Street Cars and Buses.

Beat Absenteeism in Your Plant!

WRITE FOR BIG ENLARGEMENT OF THIS POSTER FOR YOUR WAR PLANT

"Be a sweat donor, too". . . Those are fighting words for the fighters behind the front line soldiers. GEROTOR'S new "war-work-and-win"—slogan is cutting down absenteeism in war plants. It can do it for *yours* too!—and GEROTOR will be glad to help!

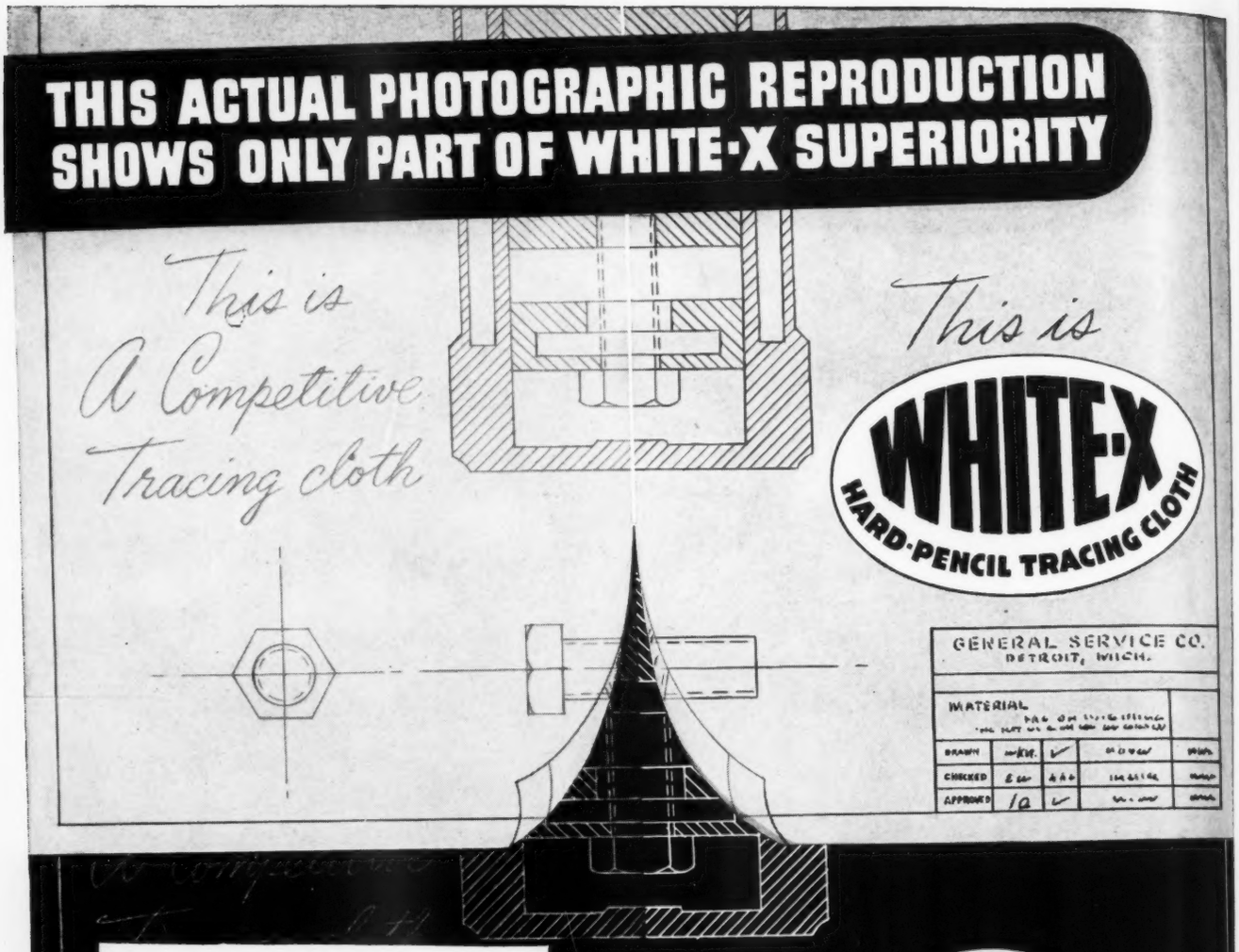
Write for as many of these large 30"x 45" "Sweat Donor" posters as you will need. We'll gladly rush them to you for your factory bulletin board . . . *with our compliments!*

GEROTOR DIVISION
May Oil Burner Corporation, Baltimore-1, Md.

PRONOUNCED JER-O-TOR REG. U. S. PAT. OFFICE
GEROTOR
LIQUID PUMPS

QUIET MAY OIL BURNERS

THIS ACTUAL PHOTOGRAPHIC REPRODUCTION SHOWS ONLY PART OF WHITE-X SUPERIORITY



MOISTURE-RESISTANCE, DUSTLESS BACK, "SEE-EASY" TRANSPARENCY ARE WHITE-X EXTRAS

On-the-board is the way to prove White-X. Your hands will "feel" the surface that takes hard pencil line with such fidelity—solid and opaque. Your eyes will enjoy that glass-like transparency and you can be proud, justifiably, of the clean, crisp drawings you produce—quickly! You'll see your prints sharply improved in detail, in unvarying background density, in finished appearance. You'll enthuse over White-X from the first pencil stroke. Free samples? We'll be glad to send them—for the asking.

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Cincinnati	MAIN 2664	Oklahoma City	3-6306
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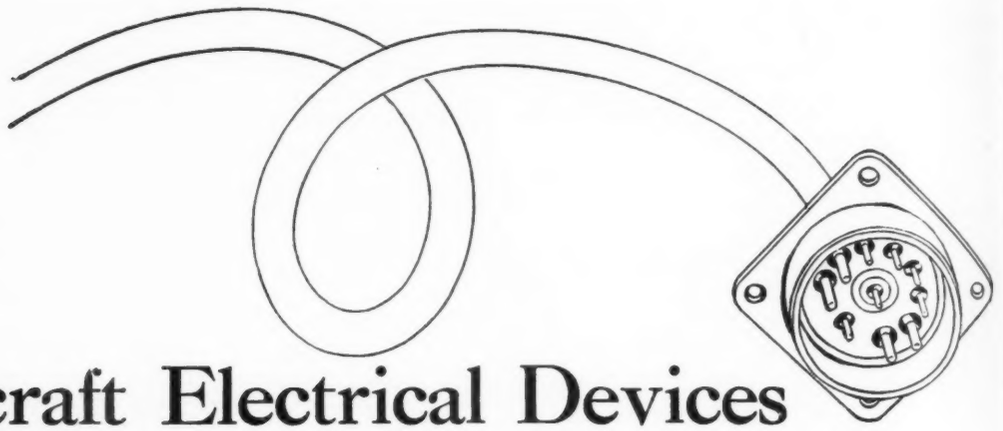

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With this unique combination of features, Chase Tellurium Copper offers outstanding advantages for the manufacture of contact pins and other electrical parts for aircraft applications—particularly where close tolerances are called for.

Full information on this unusual alloy is available on request.

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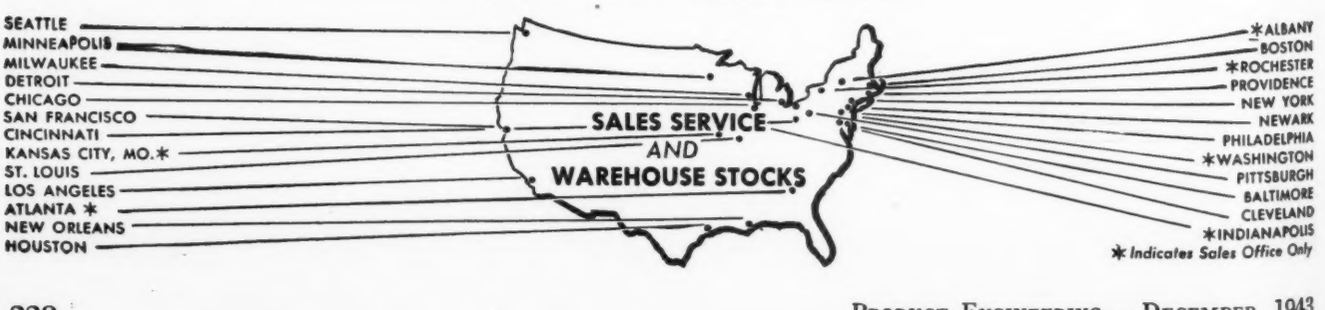

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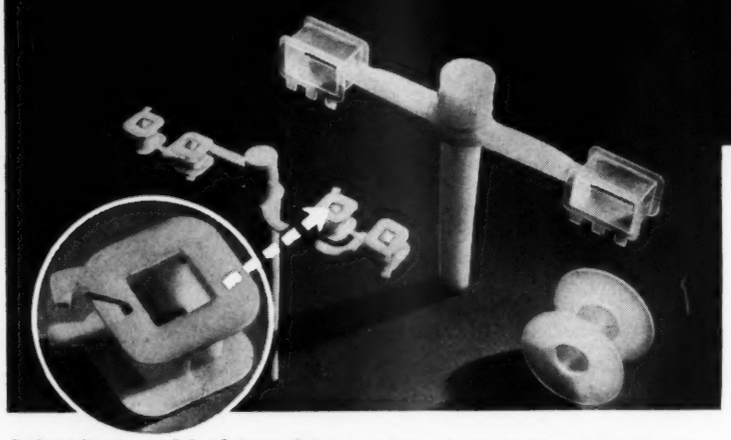
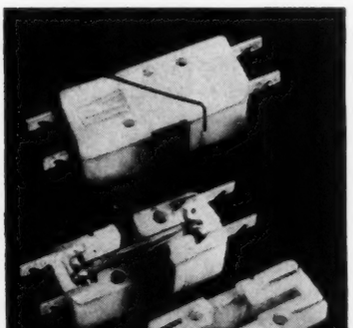
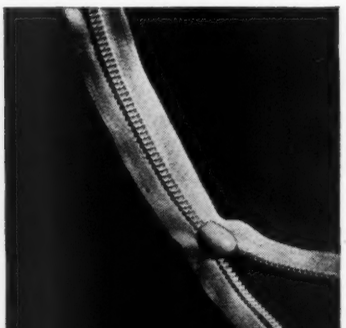


Injection-molded from FM-1 nylon, these spools for coils actuating aircraft instruments resist operating temperatures which distort other thermoplastics. Their 0.012" wall thickness is far less than that required with other molding powders for adequate strength. Sides of smaller spools can be forced together until they meet; when released, they resume shape almost instantly.



These switchette housings, injection molded from FM-1 nylon, withstand heat and strains on the job. Here, FM-1 nylon allows molding of thin, intricate walls with unusual toughness.



Nylon-molded slide fasteners resist dry cleaning solvents and heat of ironing. When injected, nylon forms a strong bond with cloth tape. Cementing is unnecessary.

An outstanding new development in Du Pont nylon is FM-1 nylon molding powder. This thermoplastic molding powder is now being produced for certain military uses, a few of which are shown at the right.

Nylon FM-1 molding powder produces articles which have remarkable resistance to high operating temperatures, to abrasion, to solvents and aging. Molded nylon articles exhibit unusual toughness and flexibility—qualities which permit its use where ordinary thermoplastics cannot be applied.

At present, production of nylon molding powder is completely under War Production Board allocation. Only small quantities are available for experimentation. But when the war is over, you'll find nylon molding powder foremost among thermoplastics offering practical advantages for your products of the future. E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Arlington, New Jersey.

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The Army-Navy "E" has been awarded for excellence in the production of plastics for aircraft and other military and essential uses.

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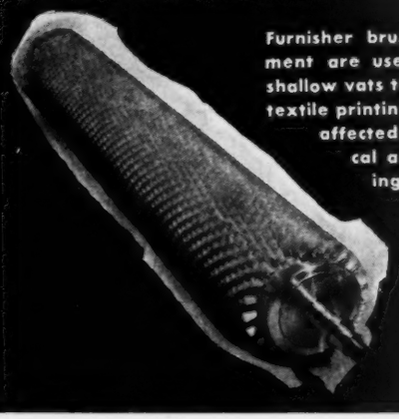
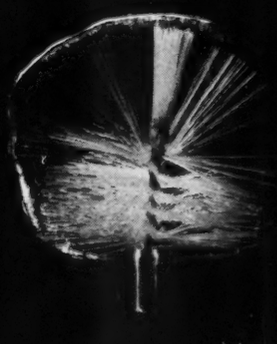


Furnisher brushes of nylon monofilament are used to convey dyes from shallow vats to engraved metal rolls in textile printing. Nylon bristles are little affected by dye solvents, chemical action during dye processing or continuous abrasion.



Nylon bristled brushes like this are used to wash blood-plasma bottles, as well as bottles of many sizes and shapes in the dairy industry. Nylon bottle brushes resist continuous whirling and flexing in mild alkali and acid solutions.

HIGHLIGHTS
Du Pont nylon

MILITARY APPLICATIONS FOR NYLON

Airplane motor part polishing brushes • Bristles for tooth and hair brushes used by armed forces • Flame actuators for airplane fire extinguisher systems • Gun-cleaning brush bristles • Catheters for armed forces Screen-cleaning brush bristles for use in explosives manufacture • Sutures • Tapered paint brush bristles

ESSENTIAL CIVILIAN USES FOR NYLON

Bristles for bottle-washing brushes • Edging brushes Electroplating brushes • Hose brushes • Hair brushes Furnisher brushes • Labeling brushes • Sewage brushes Shuttle tension brushes • Spotting brushes Tenter brushes • Tooth brushes

FREE BOOKLETS ON DU PONT PLASTICS—for engineers, designers and production men—may be secured by writing on your business letterhead to: E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Arlington, New Jersey.

1. Pamphlet on nylon molding powder—complete information on uses, molding technique and properties of nylon molding powder.

2. Du Pont Plastics Bulletin—issued periodically, giving news of developments and applications of Du Pont Plastics.

3. Manual on "Lucite"—114 pages of facts, profusely illustrated, on the forming, fabricating and properties of "Lucite" methyl methacrylate resin.

4. Booklet on Heat-Resistant "Lucite"—contains factual information on Du Pont's amazing new heat-resistant "Lucite" formula.

5. Handbook on "Plastacele"—a comprehensive handbook on best methods of fabricating Du Pont's cellulose acetate sheets.

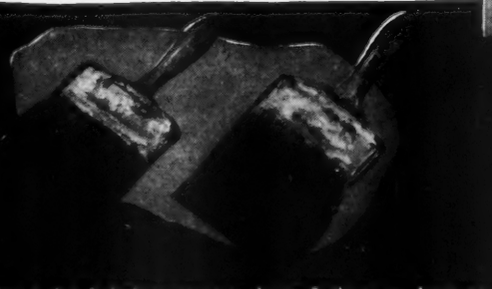
TYPICAL PROPERTIES OF FM-1 NYLON

PROPERTY	TEST RESULT	TEST METHOD
Specific gravity	1.14	ASTM D71-27
Tensile strength—70, 77, 170°F psi	16,620(1); 10,530; 9,290(2)	ASTM D638-42T
Elongation—70, 77, 170°F %	3%(1); 54%; 145%(2)	ASTM D638-42T
Modulus of elasticity 77°F psi	325,500	ASTM D638-42T
Flexural strength 77°F psi	12,600-14,600	ASTM D650-42T
Stiffness 77°F	1.89-2.02 (3)	Arlington M-9
Impact, Izod—70, 77, 170°F ft. lbs./in.	0.418; 0.944; 0.968	(8)D256-41T
Rockwell	100 L 65 H	Arlington M-29
Creep in flexure	89 (4)	Arlington P-25
Deformation under load 122°F %	4.0	ASTM D621-41T
Heat distortion temperature °F	149	ASTM D648-41T
Heat distortion temperature—low load °F	403 (5)	ASTM D648-41T
Specific heat cal/gm/°C	0.55	
Coefficient of expansion per. F°	5.7 x 10-5	ASTM D696-42T
Thermal conductivity—Btu/hr/ft²/°F/in.	1.74	ASTM D325-31T
Dielectric strength, short time—V/M	400	ASTM D149-39T
Dielectric strength, step by step—V/M	300	ASTM D149-39T
Volume resistivity ohm-cm.	10^{13}	ASTM D257-38
Dielectric constant, 60, 10^6 cycles	3.8 (6); 4 (7)	ASTM D150-41T
Power factor, 60, 10^6 cycles	1.8 (6); 5 (7)	ASTM D150-41T
Water absorption %	1.5	ASTM D570-42
Flammability in./min.	Self extinguishing	ASTM D635-41T
Methods of working	Injection, compression, extrusion	
Basic color	Light cream	
Resistant to	Esters, ketones, alkalies, alcohols, common solvents, weak acids	
Not resistant to	Phenol, formic acid, conc. mineral acids	
Outstanding for	Toughness, high temp. resistance	
Major uses	Heat resistant parts	

(THE NUMBERS IN PARENTHESES IN THE DATA REFER SPECIFICALLY TO DEVIATIONS FROM ACCEPTED TEST METHODS)

(1) —58°F
(2) 140°F
(3) Millimeters deflection at .125" thickness
(4) Mils. after 48 hours at 1600 psi and 77°F. minus original deflection
(5) 64 psi — D 648-41 T mod.
(6) 33°C dry
(7) 22°C. 18% RH, 10^3 cycles
(8) Type R conditioning

Nylon monofilaments meet Bureau of Ships ad interim Specification 38B42 for paint brush bristles.



Nylon paint bristles wear *at least 3 times as long* as top-quality hog bristles. Brush above, left, made with natural bristles, covered 23,000 feet of brick and concrete. Brush at right, made with nylon, covered the same area, but retained *strength* and *life!*

DU PONT PLASTICS

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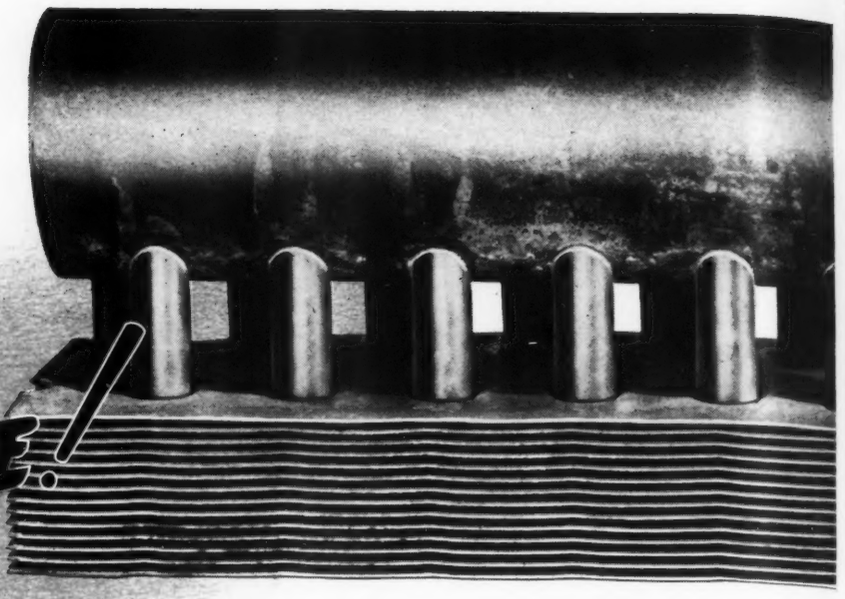
. . . Through Chemistry



A CHANGE!

from copper to steel easily handled by these SILVER BRAZING ALLOYS

Note the full penetration of EASY-FLO to the inside of each joint—a result of its exceptional fluidity and ability to flow throughout a joint in fast time.

Heat exchangers formerly were brazed in large quantities with the low-temperature silver alloys, SIL-FOS and EASY-FLO. Bronze headers and copper tubes particularly, were joined in fast time. In many plants this was a well organized, reliable, economical operation.

Then, to conserve copper, designs were changed; some to all steel construction, others to iron and steel. But **no change was necessary in the brazing procedure.** SIL-FOS joins only non-ferrous metals, so EASY-FLO simply took over the entire job—and is producing the same strong, leak-tight, permanently sound joints, with the same speed, reliability and economy, as before.

That's one of the big advantages of using this metal joining method—it is versatile—practically any metal which can be heated to the flowing temperature of SIL-FOS (1300°F) and EASY-FLO (1175°F) can be reliably joined.

GET FULL DETAILS IN BULLETIN No. 12-A

This revised bulletin gives you the facts back of SIL-FOS and EASY-FLO speed, reliability and economy. Also tells you how to put them to work in your plant, and gives valuable practical pointers on joint designs, fast heating methods and production boosting procedure.

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Advertisement DECEMBER, 1943

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by the Bridgeport Brass Co. "Bridgeport" *Headquarters for BRASS, BRONZE and COPPER*

Metallurgical Help in the Postwar Planning Picture

Improved Copper-Base Alloys Present Many Advantages For New Product Design

Practically all people in industry have been planning for the postwar period, although some call it "forward planning." At any rate, many of their ideas have at least begun to crystallize by this time. Designs for improved and new articles are undoubtedly being made in many places. These may call for metals or alloys with new combinations of characteristics.

Bridgeport's Metallurgical Laboratory can be of great service to postwar planners. Well directed development work to anticipate the requirements should be carried out now. But the Laboratory must be supplied with facts or specifications to which they can work. Solving metal problems early in the game will eliminate many unnecessary headaches on the finished product.

Choice of Materials Dependent On Economic Considerations

Much has been said and published concerning probable competition between copper-base alloys and light metals and plastics. However, the choice of material for any given service will always be based on practical manufacturing and economic considerations. If copper-base alloys, or any material for that matter, will give sufficiently better service than competing materials per dollar expended, then and then only will they be used.

The outstanding characteristic of the lighter metals and their alloys is their low specific gravity. Where lightness is of prime importance as, for example, in transportation equipment such as airplanes, railroad cars, trucks, buses, boat superstructures, and in moving parts such as piston rods and similar applications, the light metals will replace large tonnages of steel.

Advantages of Copper-Base Alloys

The chief reasons why copper-base alloys are used for modern devices can be listed somewhat as follows:

1. Ease of cold-working
2. Ease of hot-working
3. Corrosion resistance
4. Strength or hardness
5. Fatigue strength
6. Wide range of physical properties controlled by simple processing variations
7. Machineability
8. Conductivity, electrical and thermal
9. Resistance to season-cracking
10. Resistance to abrasion
11. Color
12. Ease of finishing (plating, lacquering, etc.)
13. Spring qualities
14. Ease of brazing, soldering, welding
15. Retension of physical properties at moderately elevated temperatures

In actual practice a combination of several of the above properties are required for every item manufactured.

When we consider one after another of these characteristics and compare them with the lighter metals and their alloys as well as with plastics, it becomes evident that there are very few fields where the comparison is not in favor of the copper-base alloy. Of course, there are some marginal cases where expected postwar lower prices on light metals may topple the balance, but such cases are few.

Research Provides Improved Copper Alloys At Reduced Cost

In the field of copper-base alloys, Bridgeport reports much progress in recent years because of improved efficiency in mill processing due to better and more powerful equipment and because of the vast amount of research work done to improve techniques and the alloys themselves, in addition to the development of new alloys. Much work is being done in studying the properties of existing and competing alloys as well as on corrosion research and miscellaneous investigations. Naturally many new data are available for postwar planning. The user of metals is now in a better position to select the alloys with the optimum combination of suitable characteristics to help him attain a superior product at a minimum production cost.

Typical of Bridgeport's policy of research and development is the work which the Laboratory is conducting in the field of corrosion—its causes and its remedies. Illustrated here are the results of one such corrosion problem. Depicted in the photograph at the top are samples of various metals and alloys which were, without exception, attacked by corrosion at the waterline after partial immersion for 58 days in a 10% sulphuric acid solution. Below are duplicate samples, also tested at Bridgeport's Laboratories, which showed only slight attack after partial immersion for the same length of time, but with the addition of .05% corrosion inhibitor to the sulphuric acid solution.

CAUSES OF CORROSION

This article is one of a series of discussions by C. L. Bulow, research chemist at the Bridgeport Brass Company

STEAM-EROSION

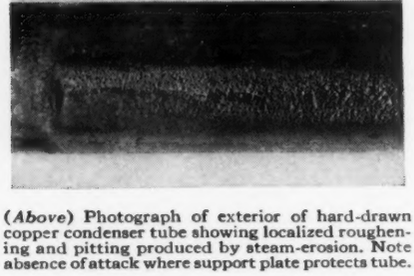
In the April and May, 1943, editions of the COPPER ALLOY BULLETIN, we discussed the effect of gas bubbles in rapidly flowing water in accelerating the corrosion of metals. Here, deep pitting of a metal is accelerated by the presence of a gas phase (bubbles) in a rapidly flowing liquid phase (water). In the erosion-corrosion of metals by steam, we find the pitting or wearing away of the metal accelerated by the presence of a liquid phase (water) in a rapidly moving gas phase (steam.) The action of wet steam travelling at high velocities, 3,000 to 4,000 feet per second, is quite surprising. Copper, brass, bronze, copper-nickel alloys, stainless steel, etc., may be eroded at rates of .001″ up to .050″ or more per year, depending upon the number and size of the water droplets, the steam

(*Continued on following page, column 1*)

CAUSES OF CORROSION

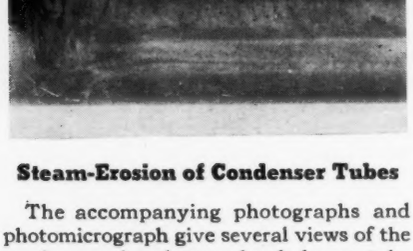
(Continued from preceding page, column 3)

velocity, and the composition of the steam. A number of investigations indicate that the size of the droplets of water in the steam is of great importance. The steam-erosion-corrosion or steam-erosion of metal by wet steam is to be found in all parts of equipment handling steam, such as steam turbine blades, condenser tubes, valve seats and discs, piston rings in steam engines, etc.



(*Above*) Photograph of exterior of hard-drawn copper condenser tube showing localized roughening and pitting produced by steam-erosion. Note absence of attack where support plate protects tube.

(*Below*) Photograph of same tube rotated to show streaming. Note profile of eroded copper.

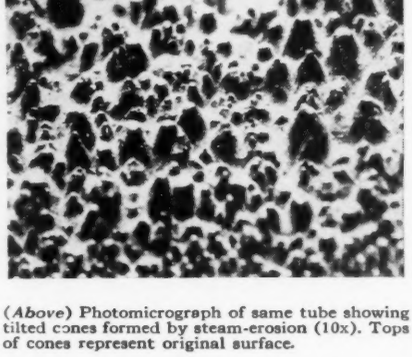


Steam-Erosion of Condenser Tubes

The accompanying photographs and photomicrograph give several views of the erosion produced on a hard drawn tube located near the throat of a condenser. Steam entered the condenser from the turbine which was located immediately above, struck a deflector plate and then glanced off the side of the copper tube. The photomicrograph (Figure 3) shows that the roughened surface actually consisted of a large number of copper cones all tilted in one direction, showing a striking resemblance to the strange formations produced by erosion of rocks in the western states.

Prevention of Steam-Erosion

Numerous attempts have been made to eliminate steam-erosion of condenser tubes. One procedure consists of removing as much moisture as possible from the steam as it leaves the last wheel of the turbine, so that a fairly dry steam reaches the condenser tubes. Since this cannot always be realized, another alternative consists of installing more steam erosion resistant materials in the area where the impingement occurs. Certain hardened stainless steels have been used with success; the soft alloys are not as resistant. Another alternative is



(*Above*) Photomicrograph of same tube showing tilted cones formed by steam-erosion (10x). Tops of cones represent original surface.

the spraying of stainless steel (by the metal spraying or metallizing process) on thoroughly cleaned sections of tubing which show evidence of erosion. This has helped in delaying the failure of the tubes by steam-erosion. Theoretically, the life of such a condenser tube could be prolonged indefinitely by repeatedly metal spraying the tubes at intervals when the sprayed metal erodes away. It seems that this method is worthy of more widespread use than is now being made of it. In dry steam regions or low velocity regions, Aluminum Brass, Duronze IV, Admiralty metal, copper, Cupro Nickel, etc. generally give very satisfactory service. (Actually in service, most condenser tube failures occur on the water side.)

Steam-Erosion of Valves

In steam valves, this phenomenon of erosion may be very severe and is commonly referred to as "wire-drawing." The valve seat or disc, or both, may be deeply eroded by wet steam. The erosion or wire-drawing may take the form of a single deep clean groove or a cavity or a number of grooves or cavities. The erosion of steam valves can be prevented to a considerable extent by:

1. Incorporating streamlined interior passages in the design of the valve and providing traps for removal of moisture before the steam enters the valves.
2. Using materials in valve seat and disc construction that are designed to provide greater resistance to steam-erosion-corrosion.

Brass valves are commonly used to handle steam up to 325° F. (approximately 100 pounds pressure, and if conditions are not too severe, up to 425° F. (approximately 300 pounds pressure.) Brass valves are seldom used for steam services above 500° to 550° F. For severe operating conditions in this temperature range, stainless steel trim is used. For higher temperatures, stainless steel or Stellite trim give satisfactory service.

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. None of these items has been tested or is endorsed by the Bridgeport Brass Company. We will gladly refer readers to the manufacturer or other sources for further information.

A Roll Type Forming Machine is now available with a 20" throat which will handle sheet metal up to 20-gage steel. Its rolls are interchangeable to combine operations of heading, crimping, flanging, trimming, turning and wiring. The hinge-mounted, motor is belt connected to the roll shafts. **(No. 510)**

An Illuminating Grinder Shield has been designed to protect the machine operator from flying particles and at the same time provide adequate lighting for his work. Designed for easy installation, this grinder shield is equipped with concealed lamps which are said to be of long-lasting quality and to provide light that is easy on the eyes. **(No. 511)**

A Foot-Operated Press for riveting, piercing, cutting, stamping and other light jobs has been made available. In two styles, for bench mounting or with floor pedestal, the press is equipped with a pendulum lever which, when kicked, moves the ram down onto the work at pressures up to two tons. The weight of the lever returns it to its initial position after each operation. **(No. 512)**

A Midget Pneumatic Vise with a maximum jaw-opening of two inches has been announced as suitable for light milling, drilling and tapping operations as well as general bench work. The moving jaw is operated by a special air cylinder, enabling the user to set the jaw travel at any point of the maximum opening. Compactly designed, it measures 10" in overall length and weighs only 12 pounds. **(No. 513)**

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Established 1865

BRASS, BRONZE, DURONZE WIRE—For cap and machine screws, wood screws, rivets, bolts, nuts.

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COPPER WATER TUBE.

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*Trade-name.

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TWO PROPELLERS INSTEAD OF ONE... FROM THE SAME AMOUNT OF STEEL!

Here's a heartening story of wartime achievement — taper-rolled steel plates for propellers.

Manufacturers used to taper these plates for propeller blades by costly machining. It was tedious work, wasted half of each plate and thousands of precious man-hours. ARMCO engineers knew there'd be a big saving if the plates could be tapered *at the mill.* So they designed ingenious rolling equipment that tapers the plates in a few swift passes through the rolls.

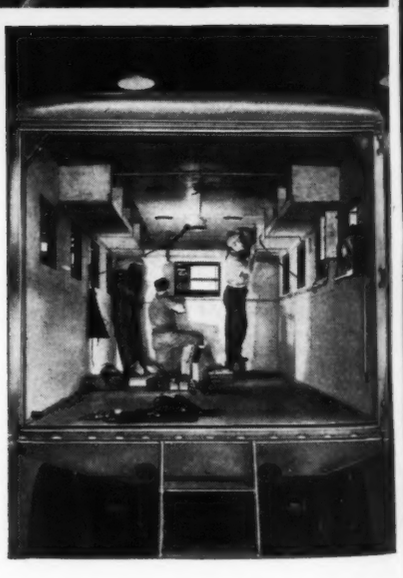
But that was only half the job. It took experienced mill men, with years of "know-how," to roll plate after plate to the highest aircraft standards. These alloy steel plates make stronger, tougher propellers for the deadly warplanes that are winning our battles in the skies.

This is only one example of ARMCO Research in action. Many special-purpose metals created by ARMCO are used in all kinds of war-winning equipment. These same steels can help you win sales for your new products when peace comes. Write to The American Rolling Mill Company, 3041 Curtis St., Middletown, Ohio.

SPECIAL PURPOSE ★ ARMCO ★ SHEET METALS

The American Rolling Mill Company

DEFENSE BEHIND THE LINES!



FRUEHAUF TRAILER COMPANY helps keep 'em rolling at the front!

HERE'S rear-guard defense...for front-line action! Trailer repair shops, built for the Army by the Fruehauf Trailer Company, put the fight back in fighting equipment . . . keep our mechanized war machine rolling at the front!

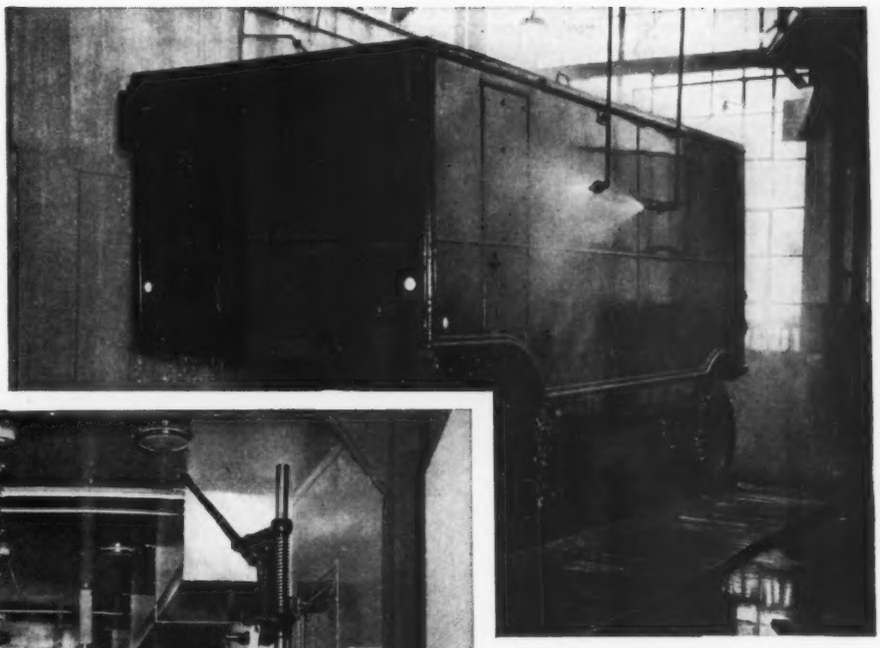
Mounted on a four-wheeled chassis with 8 tires, these repair shops are equipped with power-driven lathes, grinding machines, drills, spare parts—in fact, everything it takes to keep guns, tanks, trucks in fighting shape—in the thick of it.

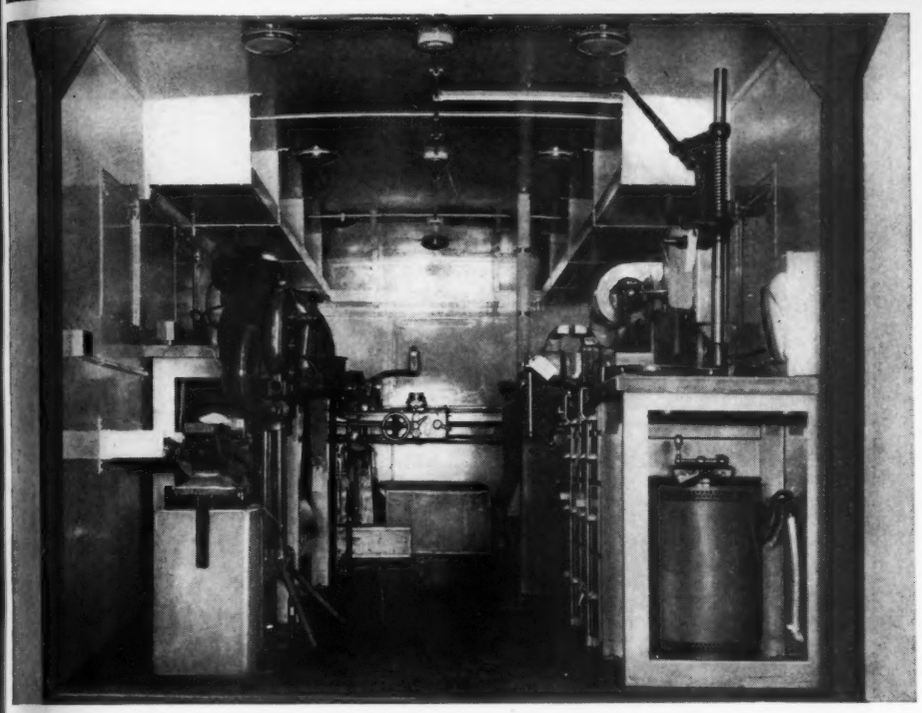
UPPER PHOTO: Applying finish coat of Sherwin-Williams Light Gray Enamel. RIGHT PHOTO: Installing plywood panels.

SHERWIN-WILLIAMS

★

WATER-TIGHT? YOU BET! *Each mobile repair shop is given a rigid test for water-tightness. High-pressure water sprays, playing on the roof and sides for hours, check for leaks, make sure Army mechanics have a snug, dry workroom.*





★

IN FIGHTING TRIM: *Completely equipped with lathes, grinding machines, drills, and spare parts — ready to give a good account of itself where the fighting's thickest and the going's toughest!*

SHERWIN-WILLIAMS gives FRUEHAUF-built mobile repair shops sure PROTECTION inside and out!

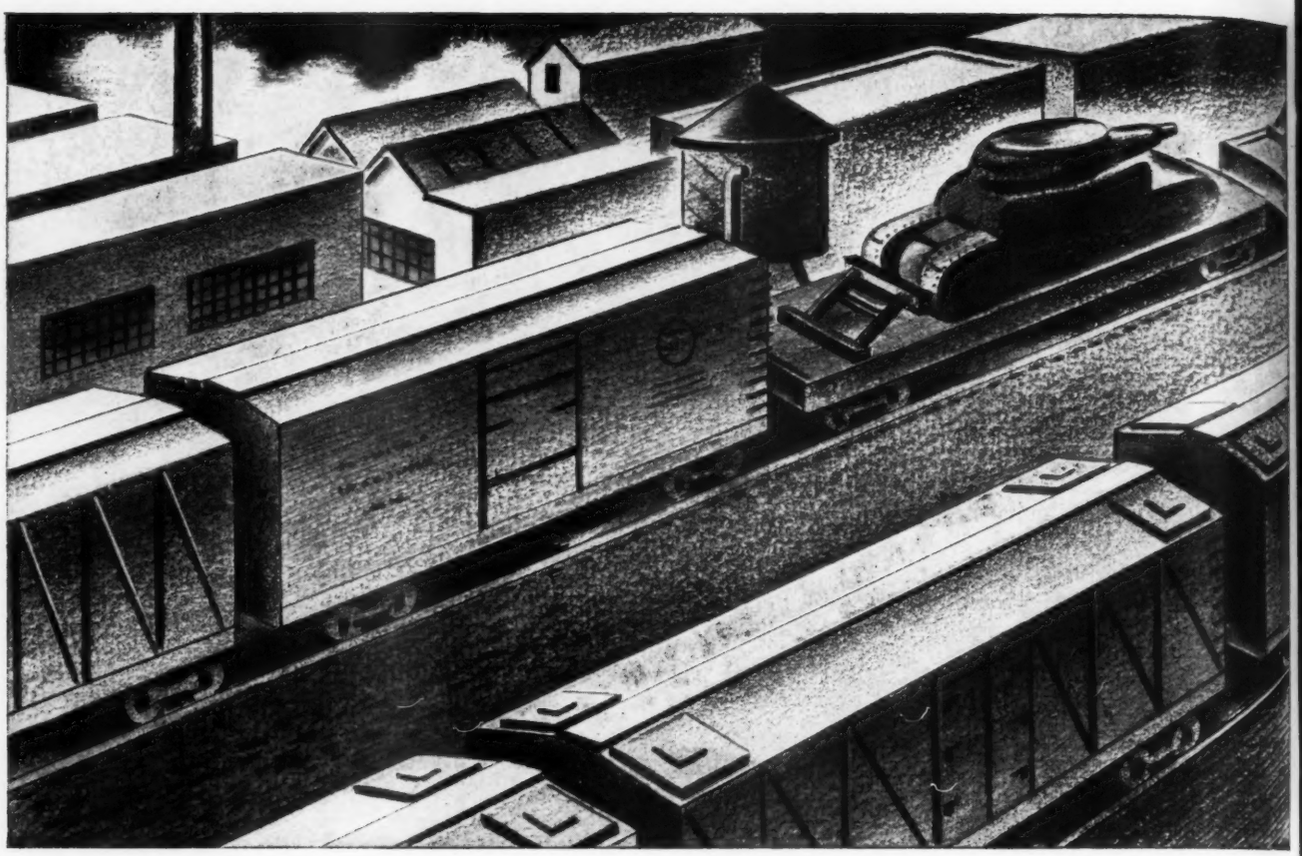
FROM start to "finish" the Fruehauf Trailer Company builds for durability. And for strong, durable finishes they use Sherwin-Williams products inside and out.

Before the equipment is installed, the walls and ceiling of the repair shops are sprayed with two coats of light gray enamel to provide maximum light reflection, yet minimize effect of dirt and grease.

The exterior is primed with a red oxide rust-inhibiting primer followed by a finish coat of dull, light-absorbent olive drab enamel. Both coats are dried in 15 to 30 minutes in a heated drying chamber.

These Sherwin-Williams finishes are doing their part in speeding up Fruehauf's finishing operations. They were formulated to fit this particular job—"geared" to Fruehauf's production schedule. They are helping Fruehauf turn out *better* finishing jobs at lowest possible unit cost. *The Sherwin-Williams Co., Cleveland 1, O.*

INDUSTRIAL FINISHES



HANDLING VITAL WAR WORK

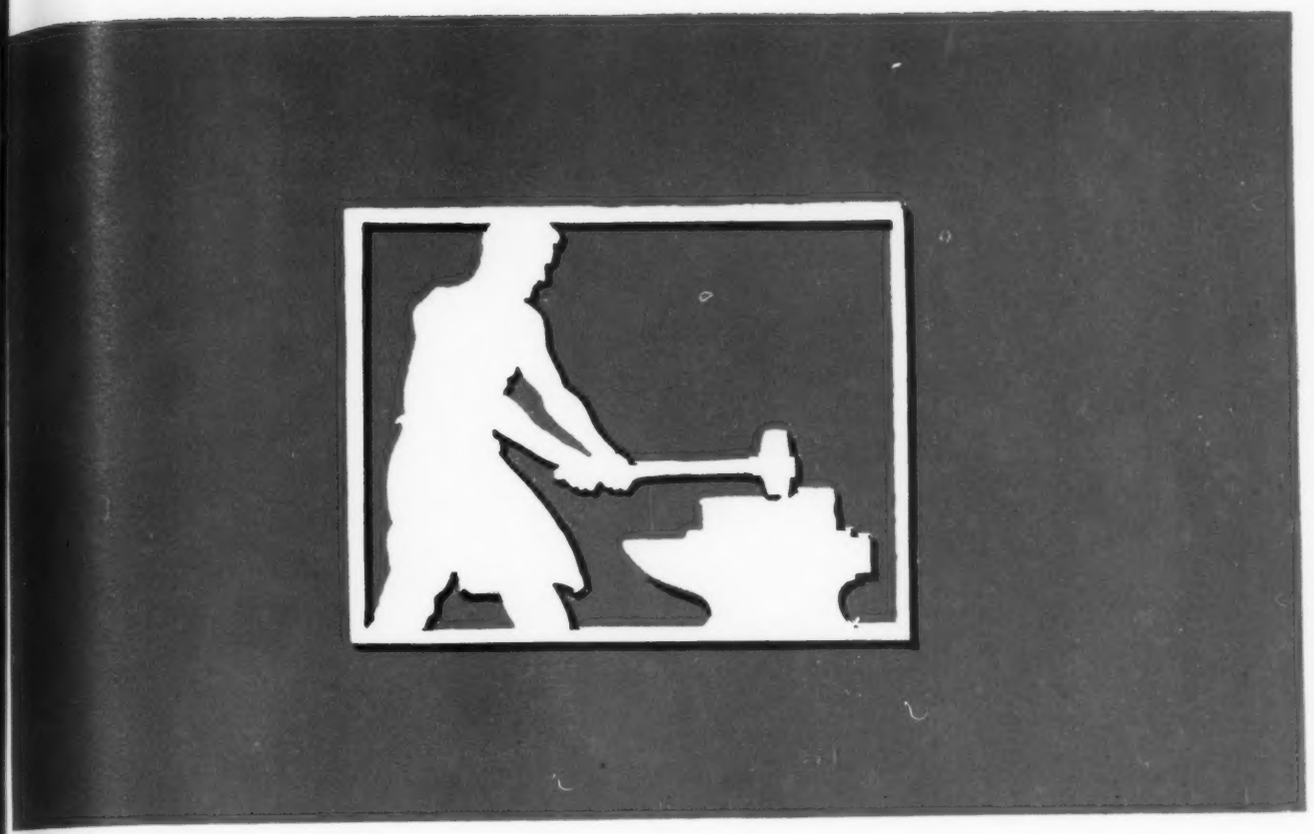
Choosing appropriate "finishes" for the Axis is our particular war job. We create handsome finishes for instruments of death . . . not to make our enemies happier, but to protect these messengers of destruction on their appointed errands.

Finishes are playing a vital role in the war . . . preventing corrosion . . . protecting against deterioration . . . . intervening against abrasion . . . . safeguarding against exposure to air, sea, acid, smoke, humidity, torrid heat, below zero cold. Stanley chemists have developed hundreds of finishes for special purposes.

Finishing may not have occurred to you as a "problem" . . . . but if you could see what is being done TODAY you would agree that, when the war is won, your present product finish may be as extinct as the dodo bird.

Stanley chemists . . . . experts in this field . . . . can show you how to improve your product by improving its finish. Your inquiry incurs no obligation. Address The Stanley Chemical Company . . . manufacturers of Stanley Lacquers, Enamels, Synthetics and Japans . . . East Berlin, Connecticut.

Stanley Chemical



Follansbee for Steel

Sterling for Silver

What "Sterling" means to silver, the "Follansbee Smith" means to open hearth steel.

Ever since Madison was President, the Follansbee Steel Corporation and its predecessors have continuously enjoyed a reputation for quality. First it was as an importer of bar iron and tin plate, later as a steel producer. Products have changed. Methods have changed. But the policy of making products of the highest possible standard has remained constant.

Today, Follansbee's compact, highly skilled organization is continuing that reputation by its ability to produce quality steel to meet the specialized requirements of its customers. Look for "Sterling" on silver . . . look for the "Follansbee Smith" on steel.

FOLLANSBEE STEEL CORPORATION

GENERAL OFFICES • PITTSBURGH 30, PA.

Sales Offices—New York, Rochester, Cleveland, Detroit, Milwaukee. *Sales Agents*—Chicago, St. Louis, Nashville, Los Angeles, Toronto and Montreal, Canada. *Plants*—Follansbee, W. Va. and Toronto, Ohio

ALLOY BLOOMS, BILLETS, BARS, SHEETS & STRIP
COLD ROLLED SHEETS & STRIP • POLISHED BLUE SHEETS • ELECTRICAL SHEETS & STRIP • SEAMLESS TERNE ROLL ROOFING

Enlarged reproduction free on request

Wissco Springs *Deliver*

Right now Wissco spring and formed wire dependability is helping to finish this important job in—

Plane motors	Army trucks	Submarines
Instruments	Scout cars	Torpedoes
Parachutes	Jeeps	Machine guns
Trainers	Destroyers	Automatics
Tanks	Cruisers	Gun carriages

When that job is done, Wissco springs and formed wires will be ready to help win the Peace, by contributing their efficiency to better automobiles, refrigerators, vacuum cleaners and the multitude of other products of American industry.

Back of Wickwire Spencer super-dependability are 122 years of pioneering many of the basic advances in wire and wire products . . . and the accumulated skill of the thousands of Wickwire Spencer craftsmen and craftswomen. When *you* want wire or wire products, put your needs up to experts. Write for data book.

Copyright 1943

WICKWIRE SPENCER STEEL COMPANY

500 FIFTH AVENUE NEW YORK (18), N. Y.

Worcester, Philadelphia, Buffalo, Chicago, Chattanooga, Detroit, San Francisco, Los Angeles, Tulsa, Houston, Abilene

FAMOUS FOR QUALITY IN WIRE, WIRE ROPE, SPRINGS, METAL CONVEYOR BELTS, INDUSTRIAL WIRE CLOTH, POULTRY NETTING, HARDWARE CLOTH, INSECT SCREEN CLOTH, ELECTRICALLY WELDED FABRIC FOR CONCRETE

WS STANDS FOR FRIENDLINESS

FROM OUR MILLS TO THE MOON

Placed end to end, the cartridges made for this war from brass produced by our mills would reach clear to the moon and more than halfway back to the earth—a total of 374,885 miles.

Such volume production staggers the imagination—yet for every cartridge in every billion produced by Western-operated ammunition plants, our brass mills are rigidly holding to unbelievably close tolerances.

In addition, hundreds of thousands of tons of "tailor-made" brass are being produced for many other types of war equipment by our mills at East Alton, Ill., and New Haven, Conn., thereby contributing to the day when Victory will again make it possible for us to serve you.

Western BRASS PRODUCTS

Western BRASS MILLS

Division of WESTERN CARTRIDGE COMPANY, *East Alton, Ill.*

To-morrow **VICTORY** *and Peace*

Our Christmas message is concerned with To-morrow... and all that it means. This hour... this day brings up the ultimate question, "What for To-morrow?"

All of the To-morrows depend on our efforts to-day, and the Destiny of this and the next generation depends on our ability to overcome all the grave problems which face us hourly.

This is a test of our endurance. The Blood, Sweat and Tears of all of us, the unity of purpose and the determination of a free people, will maintain the peace and the liberty of our way of life. The Reynolds organization re-dedicates itself to this task.

★

BUY WAR BONDS

Reynolds Plastics

REYNOLDS MOLDED PLASTICS
CAMBRIDGE, OHIO, U. S. A.

REYNOLDS SPRING COMPANY
JACKSON, MICHIGAN

AUTO-LITE WIRE and CABLE

Made in specifications that meet every need . . .

PLASTIC

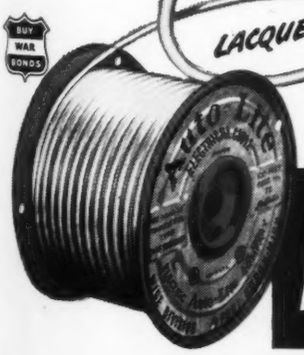
SYNTHETIC RUBBER

RUBBER

ENAMEL

GLASS

LACQUER



Auto-Lite Wire and Cable can meet the electrical need of your product. Wire is supplied in a full range of sizes, shapes and materials. Insulations of all types are available including special developments like Auto-Lite's Vega Chromoxide Enamel, an insulation of decided advantage where resistance to heat is of paramount importance.

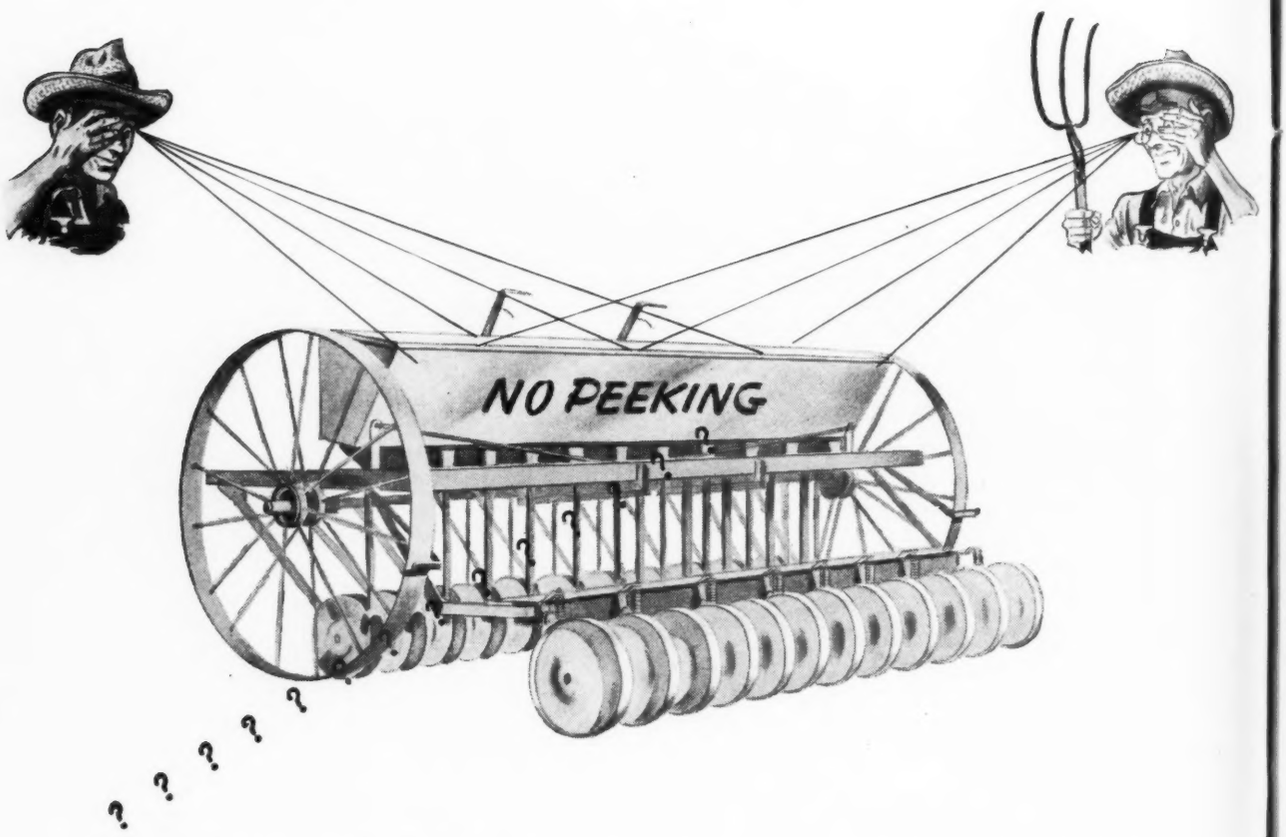
Equally revolutionary advances in other types of wire and cable have helped manufacturers perfect products with increased heat resistance, improved performance characteristics...and often at decided savings in cost.

For further information on your specific problem, write to

THE ELECTRIC AUTO-LITE COMPANY

SARNIA, ONT. *Wire Division* PORT HURON, MICH.

AUTO-LITE *ELECTRICAL* WIRE and CABLE



WHAT'S SO SECRET ABOUT A FARM MACHINE?

Perhaps you're interested in farm machinery. Perhaps not. But the simple idea of designing a machine, or product, with more practical "see through" utility is one that should appeal to you.

We use farm machinery as an example. Why not make the hoppers of grain drills, seeders, planters or lister planters so the farmer could watch what is going on inside . . . watch the level of the seed . . . know that it is feeding properly . . . know exactly when refilling is required?

Or take the many working parts of a combine, or a corn sheller. Or a cream separator? How much more convenient if the user could always see that these parts are operating properly?

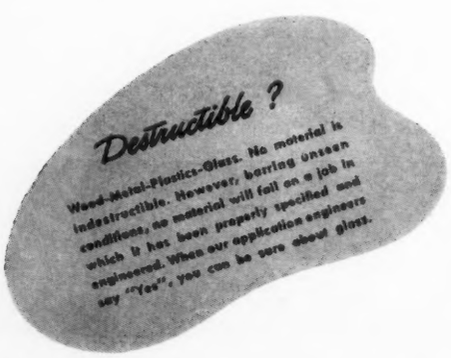
It's a simple idea, with a simple answer: make better use of a transparent material. Glass, of course. Not the glass of years ago. But modern L·O·F glass.

Glass is one of the few materials you *can* see through. (It's tops in that) But there's a lot more to this material. Dimensionally, glass is one of the most stable materials. Its surfaces are among the hardest and smoothest known. Nonporous. Acid-resisting. Unusually resistant to abrasion.

And modern L·O·F glass is strong. The way we temper glass a square foot, quarter-inch thick will withstand a pressure of 60 pounds per square inch and has a modulus of rupture of 30,000 pounds per square inch. We can laminate it with other materials. Give it to you with a metal collar. Or in multiple units that insulate. Or in special types that repel the sun's heat or ultraviolet rays. The final product may be had in flat sheets or bent shapes.

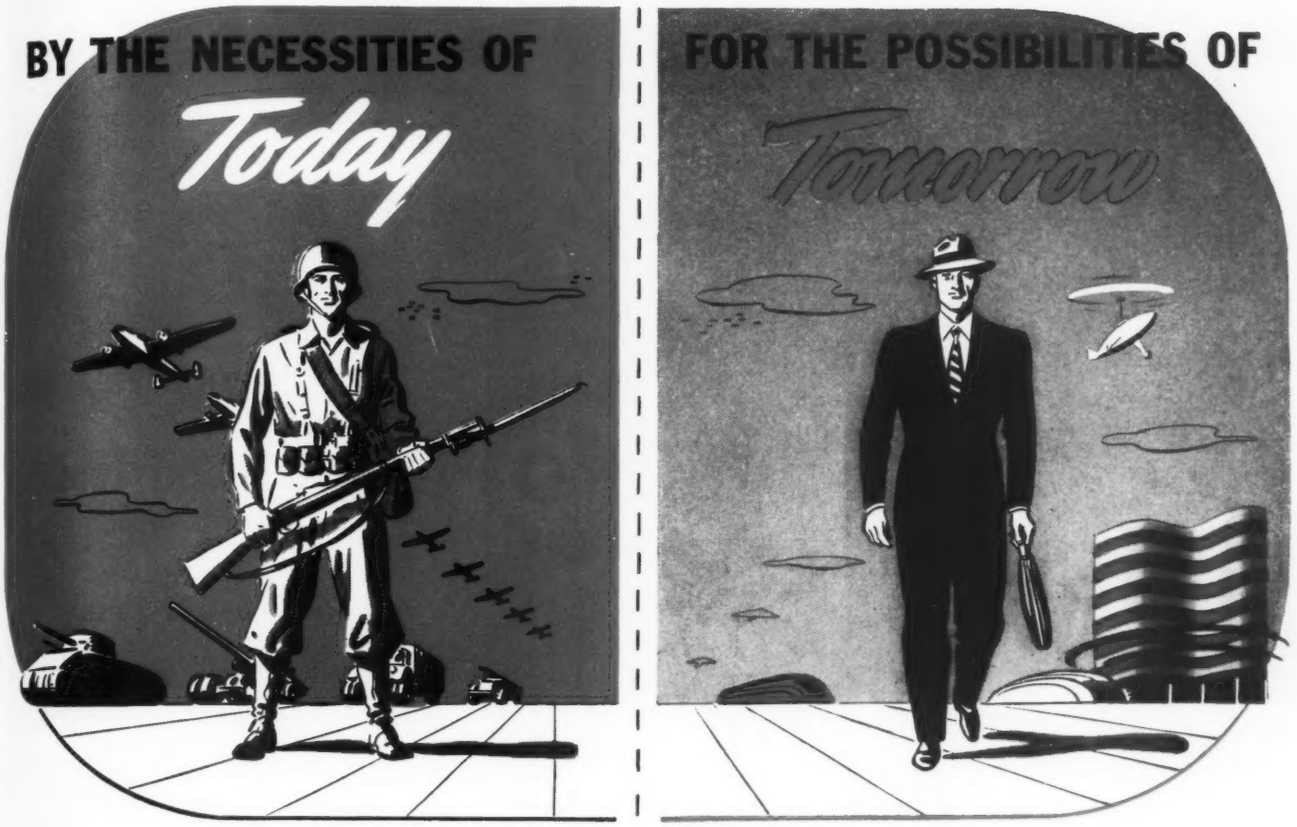
So just remember when you design any product for the home, for industry, or for any structure, there *is* a material that's strong and long lasting . . . and transparent. It's glass!

Perhaps glass fits your product or plant. Won't you write us about any use that interests you? That's the way to really find out. Libbey·Owens·Ford Glass Company, 16123 Nicholas Building, Toledo 3, Ohio.


Destructible ?
Wood-Metal-Plastics-Glass. No material is indestructible. However, barring unseen conditions, no material will fail on a job in which it has been properly specified and engineered. When our application engineers say "Yes", you can be sure about glass.

L·O·F LIBBEY·OWENS·FORD
A GREAT NAME IN *Glass*

SKILLS SHARPENED



★ American industry is today meeting the necessities of wartime production with such vigor that the Allied output of war materials is three times the Axis output.

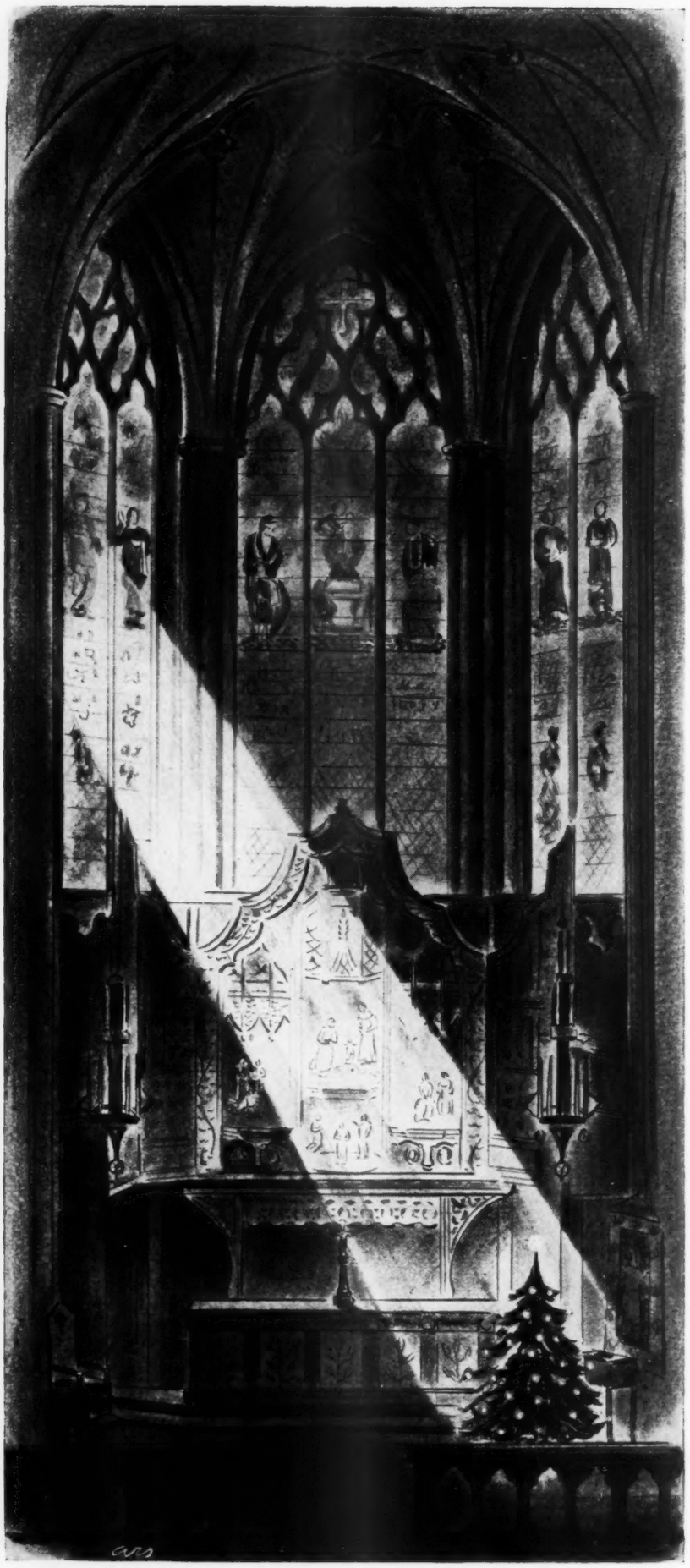
Here at Aluminum Industries, skills acquired through many years of pioneering development work and experience in casting aluminum and magnesium alloys have been sharpened and refined by the demands of war.

When the war is over, Aluminum Industries will be prepared to apply today's knowledge to tomorrow's possibilities, offering even finer products — even better service — to help industry serve a world at peace.

ALUMINUM INDUSTRIES, INC., CINCINNATI, OHIO

Detroit: 902 New Center Building
Los Angeles: 324 North San Pedro Street
Chicago: 616 South Michigan Avenue

PERMITE ALUMINUM AND MAGNESIUM ALLOY CASTINGS

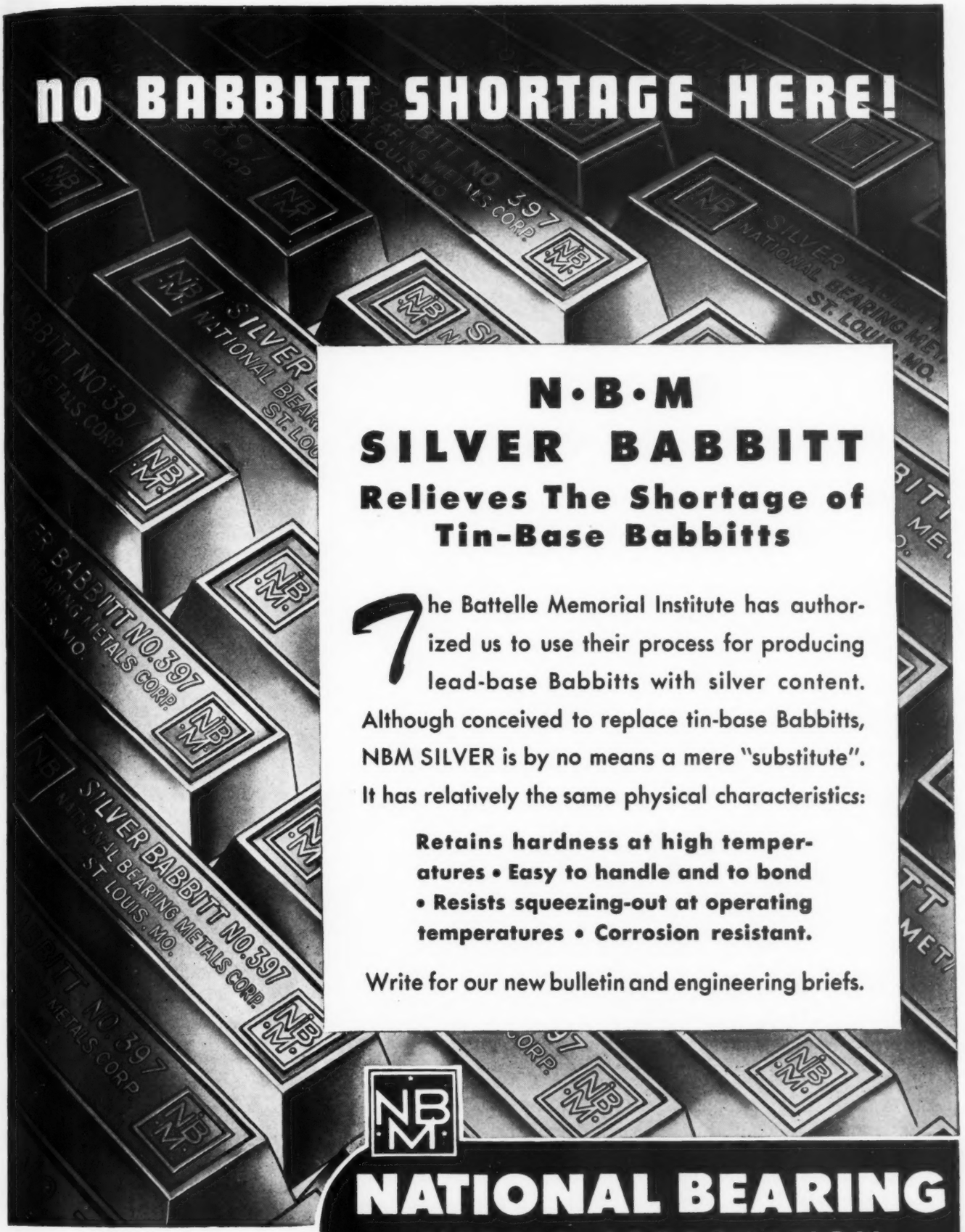


One prayer in every heart . . . for Christmas

That the coming years will bring to mankind everlasting peace . . . enduring friendship between nations . . . Preservation and propagation of cherished American freedom; that this world shall be a Free World.

NIXON Plastics

NIXON NITRATION WORKS • NIXON • NEW JERSEY


NO BABBITT SHORTAGE HERE!
N·B·M
SILVER BABBITT
Relieves The Shortage of
Tin-Base Babbitts
The Battelle Memorial Institute has authorized us to use their process for producing lead-base Babbitts with silver content. Although conceived to replace tin-base Babbitts, NBM SILVER is by no means a mere "substitute". It has relatively the same physical characteristics:
Retains hardness at high temperatures • Easy to handle and to bond • Resists squeezing-out at operating temperatures • Corrosion resistant.
Write for our new bulletin and engineering briefs.
NBM
NATIONAL BEARING
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ST. LOUIS • NEW YORK
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PLANTS IN: ST. LOUIS, MO. • PITTSBURGH, PA. • MEADVILLE, PA. • JERSEY CITY, N. J. • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

Supercar!

(From the Drawing Boards of Sundberg and Ferar)

PLANS for post-war driving call for "supercars" in plastic as suggested by the above conception of outstanding industrial designers.

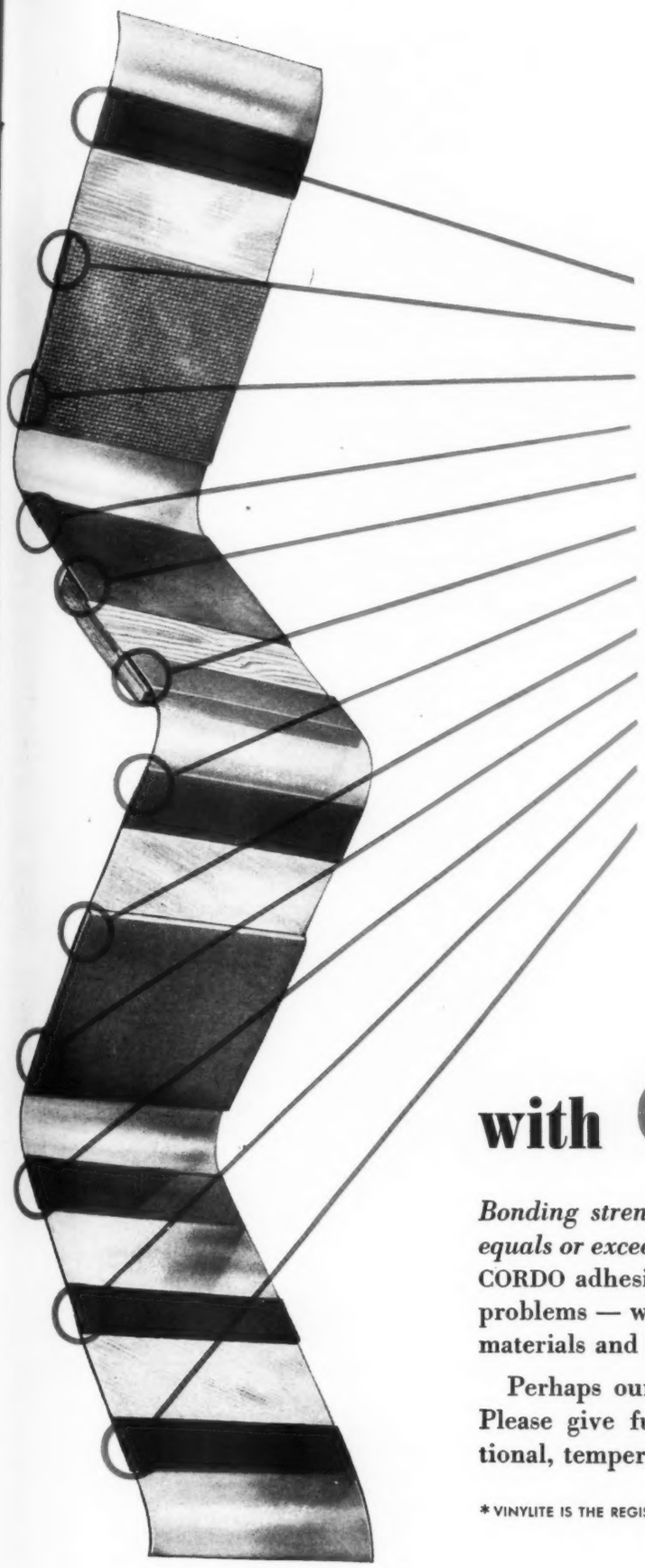
The combination of light weight, strength and moulding-quality of plastics, plus new moulding techniques, make possible this streamlined, tear-drop body design. Full-vision plastic windows offer new driving safety and pleasure. Plastic accessories and trim add to beauty and to economy of production.

But plastic "supercars" are only one of the many things designers and engineers are thinking of in terms of the future. Planning-ahead in plastics is unrestricted. *In every field* of industrial and consumer application, plastics are being seriously considered for tomorrow. To help you plan your products for the future, call upon the well rounded experience of Kurz-Kasch craftsmen . . . plastic engineers, toolmakers and moulders . . . specialists in plastic design and production for more than a generation.

KURZ-KASCH

Planners and Molders for the Age of Plastics

Kurz-Kasch, Inc., 1417 South Broadway, Dayton, Ohio
Branch Sales Offices: New York • Chicago • Detroit • Los Angeles • Dallas • St. Louis • Toronto, Canada. *Export Offices:* 89 Broad St., New York City



BRASS BONDED TO VINYLITE *

PRESDWOOD BONDED TO BRASS

VINYLITE BONDED TO PRESDWOOD

SHEET IRON BONDED TO VINYLITE

PLYWOOD BONDED TO SHEET IRON

VINYLITE BONDED TO PLYWOOD

MAGNESIUM BONDED TO VINYLITE

"BAKELITE" BONDED TO MAGNESIUM

VINYLITE BONDED TO "BAKELITE"

GLASS BONDED TO VINYLITE

ALUMINUM BONDED TO GLASS

VINYLITE BONDED TO ALUMINUM

All Perfect Bonds with CORDO Adhesives

Bonding strength approaches, and, in some combinations, equals or exceeds the strength of the materials being bonded. CORDO adhesives were developed to meet specific bonding problems — working closely with the manufacturer, his materials and his methods.

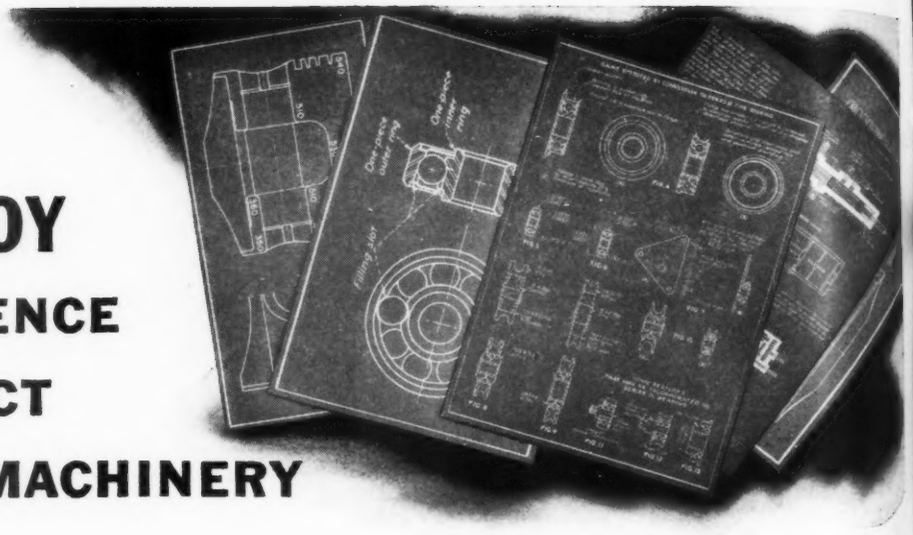
Perhaps our research laboratory can be of help to you. Please give full details of your bonding problem, operational, temperature and pressure facilities.

* VINYLITE IS THE REGISTERED TRADE MARK OF CARBIDE AND CARBON CHEMICALS CORPORATION

CORROSION CONTROL CORPORATION
(AFTER JANUARY 1, 1944—CORDO CHEMICAL CORPORATION)
34 Smith Street, Norwalk, Connecticut
INDUSTRIAL COATINGS • FINISHES • LACQUERS • ADHESIVES

CORDO

HOW NITRALLOY WAR EXPERIENCE WILL AFFECT PEACE-TIME MACHINERY



The stamina of military aircraft engines and vital tank parts can be built into postwar machinery with NITRIDED NITRALLOY. Fight wear and fatigue of metals with this treated alloy steel that has won the distinction of use where nothing will do but the *hardest steel surface known*—a hardened case unmatched for resistance to abrasion and shock, integrally bound to a core with properties controlled to meet individual requirements. This distinction of use has been won under handicap of a severe shortage of some important alloys that make NITRALLOY withstand abuses that no substitute can resist. When these alloys are again available for broader use, NITRIDED NITRALLOY will contribute to the life and reliability of peace-time machinery.

In your postwar product planning, consider NITRIDED NITRALLOY for:

ARBORS	MANDRELS	SHACKLES
BEARINGS	NOZZLES	SHAFTS
BUSHINGS	PINIONS	SOCKETS
CAMS	PINS	SPINDLES
CONNECTING RODS	PISTONS	SPLINES
CONVEYOR CHAINS	PISTON RODS	SPROCKETS
CRANKSHAFTS	PINTLES	STRIPPER PLATES
CYLINDER BARRELS	PIVOTS	STUDS
CYLINDER LINERS	PLUNGERS	TAPPETS
DIES	PUMP PARTS	THRUST WASHERS
EJECTOR PINS	PUSH RODS	TIE ROD BOLTS
FAN BLADES	RATCHETS	VALVES
GAGES	RETAINING RINGS	VALVE SEATS
GEARS	ROCKERS	WEAR PLATES
GUIDES	ROLLS	WORMS
KING PINS	ROLLERS	WRENCHES
LINKS	SCALE PARTS	YOKE NUTS

It is none too early to call for our help in planning the material for your new peace-time products. Our applications engineers will gladly consider your requirements and submit recommendations. Availing yourself of this assistance imposes no obligation upon you.

The following technical books will be supplied promptly on request written on the inquirer's business stationery: "Nitralloy and the Nitriding Process", "Fatigue of Metals—Facts for the Designing Engineer", "Hardness" and "Nitriding Furnaces"

COMMONLY USED NITRALLOY STEELS:

	Nitralloy 125 (Type H)	Nitralloy 135 (Type G)	Nitralloy 135 Modified (Aircraft Specification)	Nitralloy N (3½% Nickel)	Nitralloy 230 (Alamo)	Nitralloy EZ (Type G with Se)
CARBON	0.20-0.30	0.30-0.40	0.38-0.45	0.20-0.27	0.25-0.35	0.30-0.40
MANGANESE	0.40-0.60	0.40-0.60	0.40-0.70	0.40-0.70	0.40-0.60	0.50-1.10
SILICON	0.20-0.40	0.20-0.40	0.20-0.40	.....	0.20-0.40	0.20-0.40
CHROMIUM	0.90-1.40	0.90-1.40	1.40-1.80	1.00-1.30	.....	1.00-1.50
ALUMINUM	0.90-1.40	0.90-1.40	0.95-1.35	1.10-1.40	1.00-1.50	0.75-1.50
MOLYBDENUM	0.15-0.25	0.15-0.25	0.30-0.45	0.20-0.30	0.60-1.00	0.15-0.25
NICKEL	.....	.....	.....	3.25-3.75	.....	.....
SELENIUM	.....	.....	.....	.....	.....	0.15-0.25

THE NITRALLOY CORPORATION

230 PARK AVENUE, NEW YORK 17, N. Y.

Companies Licensed by The Nitralloy Corporation

Allegheny Ludlum Steel Corp. *Watervliet, N. Y.*
Bethlehem Steel Co. *Bethlehem, Pa.*
Copperweld Steel Co. *Warren, O.*
Crucible Steel Co. of America *New York, N. Y.*
Firth-Sterling Steel Co. *McKeesport, Pa.*
Republic Steel Corporation *Cleveland, O.*
The Timken Roller Bearing Co. *Canton, O.*
Rotary Electric Steel Co. *Detroit, Mich.*
Vanadium-Alloys Steel Co. *Pittsburgh, Pa.*
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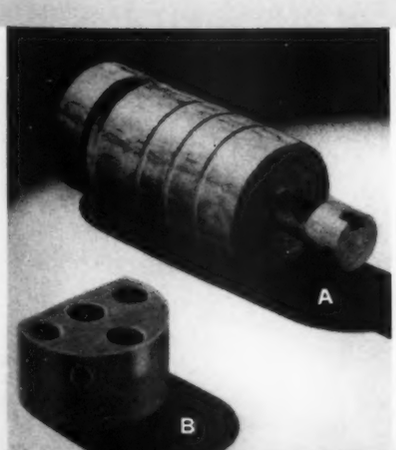
Met-Lab, Inc. *Philadelphia, Pa.*
New England Metallurgical Corp. *Boston, Mass.*
Pittsburgh Commercial Heat Treating Co. *Pittsburgh, Pa.*
Queen City Steel Treating Co. *Cincinnati, O.*
Rex & Erb *Lansdale, Pa.*
The Salkover Metal Processing Co., Inc. *Long Island City, N. Y.*
Wesley Steel Treating Co. *Milwaukee, Wis.*
N. A. Woodworth Co. *Ferndale, Mich.*
Ontario Research Foundation *Toronto, Ontario, Canada*

Manufacturers of Nitralloy Steel Castings

Lebanon Steel Foundry *Lebanon, Pa.*
Empire Steel Castings Co. *Reading, Pa.*
The Massillon Steel Castings Co. *Massillon, O.*
Milwaukee Steel Foundry Div., Grede Foundries, Inc. *Milwaukee, Wis.*
Warman Steel Castings Co. *Los Angeles, Cal.*

Scratch One Zero!



A—Airbrake piston—drilled, turned and grooved on the lathe, milled.
B—Insulator—bandsawed, turned, drilled, and counterbored.

WHEREVER Navy buzzard-busters swing into action, you'll probably find Synthane.

The reason is plain. The self-same qualities that suggested Synthane for peacetime products fit it for the implements of war. A few of these advantages worth pasting in your hat for future reference are light weight (half the weight of aluminum), excellent dielectric characteristics, resistance to corrosion, structural strength, and ease of machining. There are many more.

The time will come when ack-ack need no longer clear trouble-charged skies. Then industrial plastics, such as Synthane, will return and find many new jobs waiting. As you look forward to that day, read the data on the back of this sheet or write to us for present help on future work.

SYNTHANE CORPORATION, OAKS, PENNSYLVANIA

Plan your present and future products with Synthane Technical Plastics

SHEETS • RODS • TUBES • FABRICATED PARTS SYNTHANE MOLDED-LAMINATED • MOLDED-MACERATED

SYNTHANE "Sandwich" Materials

One of the advantages of Synthane is the ease with which it can be bonded to other materials to produce a substance with the combined advantages of the partnership. Bonding takes place under heat and high pressure, during the polymerization of the Synthane; it is not a mere joining of two surfaces with an adhesive. The resulting combination, therefore, shows little or no tendency to delaminate.

Synthane combinations are familiarly known as Synthane "sandwich" materials, an appropriate name, for many different kinds of combinations are possible.

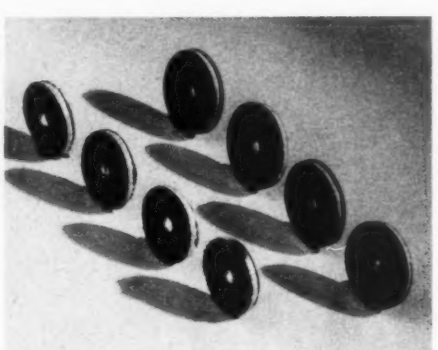
Probably the most widely used combination brings Synthane and rubber together.

Synthane-Rubber

Synthane-rubber combinations are advantageous where the strength of Synthane is desirable to back up rubber.

An interesting application concerns a washer used in electrolytic and oil type condensers. The washer is placed on the end of tin can electrolytic condensers with the Synthane face exposed to the chemicals to prevent deterioration. The can is crimped into the rubber to make a tight seal.

A similar washer is used on "bath-tub" condensers. Tough Synthane provides a firm seat for a nut which compresses the rubber to form a tight joint.



Combinations of rubber and Synthane have been furnished with rubber on one side, Synthane on the other; rubber on both sides with Synthane between; Synthane on both sides and rubber between; and alternate laminations of rubber and Synthane built up to any desired thickness.

There are many more possible uses for Synthane-rubber sandwich materials, which we cannot describe because of military censorship. There are also many important uses for a combination of Synthane and Neoprene.

Synthane-Synthane

Occasionally two grades of Synthane are combined. For instance, in certain radio tube sockets, layers of fabric and paper base Synthane are combined. The paper base has usually better electrical properties while the fabric base furnishes added strength where the stress is greatest.

Bobbin heads in the textile industry are often made of paper and fabric bases combined. The fabric base endures rough handling, whereas the paper base on the inside of the head provides a smooth wearing surface.

Synthane-Asbestos

Synthane is wound about asbestos (or fibre) tubes and cured in the manufacture of tubing for large fuse cases. Synthane adds strength and rigidity to the fire resistance of the asbestos or fibre.

Synthane-Other Materials

Synthane can be united with a variety of materials to produce a variety of practical combinations. We have made or experimented with other combinations. If you have any combination in mind which we have not explored, we will be glad to investigate its possibilities for you.

PLAN YOUR PRESENT AND FUTURE PRODUCTS WITH SYNTHANE TECHNICAL PLASTICS

SYNTHANE

SHEETS • RODS • TUBES • FABRICATED PARTS • MOLDED-LAMINATED • MOLDED-MACERATED

SYNTHANE CORPORATION, OAKS, PENNA.

REPRESENTATIVES IN ALL PRINCIPAL CITIES

EVER TAKE A MACHINE GUN APART?

A SOLDIER has to be able to do it blind-folded. And because he knows how, parts, accurate to the thousandths of an inch and produced in mass-production quantities, come apart and go together again in a matter of minutes.

Even the layman can understand how vital is precision in every item of fighting equipment like this. Take the bullet belt links for example. They've got to be uniformly perfect or the gun will jam in combat.

That unfailing uniformity starts with the strip steel from which those bullet links are made.

Every pound of American Quality Cold Rolled Strip we furnish in vast quantities for these high precision parts has to be—and *is*—"right on the nose" in chemical analysis, structure, dimensions and straightness. Otherwise, subsequent operations would fail to produce perfect links.

And because speed of manufacture is important, we further insure perfect workability in this material by bright annealing in furnaces of improved design. It enables the fabricator to set his dies and machinery for top-speed manufacture with full confidence of getting the precise results desired.

If you are fabricating cold rolled strip steel for war products, our metallurgical engineers will gladly help you use it to the best advantage.

AMERICAN STEEL & WIRE COMPANY

Cleveland, Chicago and New York

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
United States Steel Export Company, New York

USS

American Quality
COLD ROLLED STRIP STEEL

COLD FINISHED STEEL BARS
MANUFACTURERS' WIRE · STAINLESS
STEEL SPRING WIRE · WELDING WIRE
WIRE SPRINGS

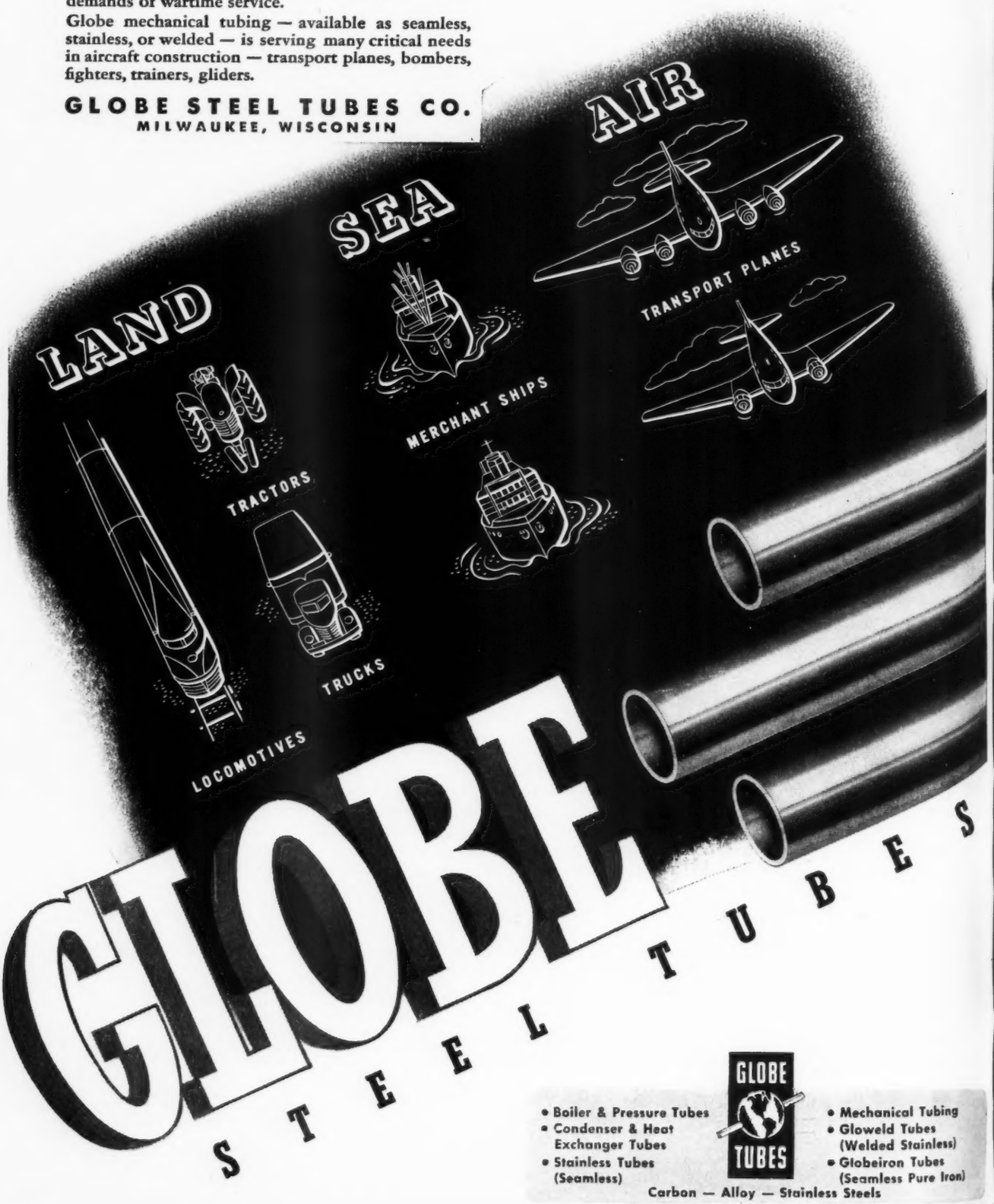
UNITED STATES STEEL

INDISPENSABLE
. . . IN THE CONSTRUCTION OF TRANSPORT EQUIPMENT

In locomotives — in the power plants of war industries — in fighting, transport and merchant ships — Globe seamless steel tubes are meeting the extra demands of wartime service.

Globe mechanical tubing — available as seamless, stainless, or welded — is serving many critical needs in aircraft construction — transport planes, bombers, fighters, trainers, gliders.

GLOBE STEEL TUBES CO.
MILWAUKEE, WISCONSIN



- Boiler & Pressure Tubes
- Condenser & Heat Exchanger Tubes
- Stainless Tubes (Seamless)
- Mechanical Tubing
- Gloweld Tubes (Welded Stainless)
- Globeiron Tubes (Seamless Pure Iron)

GLOBE TUBES

Carbon — Alloy — Stainless Steels

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HARD FACING ALLOYS AND OVERLAY METALS

Your production schedules would be mighty easy if your equipment never wore out.

When machinery wears to the point that it is useless for its particular function, you will find that the wear is localized—one place wears out before the rest.

Coat these critical places with the proper grade of COLMONOY. The application is easy to make, by standard welding methods. You will find that parts so treated will give service many times as long as will uncoated parts. Worn and discarded equipment, when hard-faced with COLMONOY not only goes back to work, but outwears and outperforms new, uncoated equipment.

Our new Catalog No. 75 gives full information on all grades of COLMONOY and shows pictures of many types of application in different industries. Write for your copy today.

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CATALOG NO. 75

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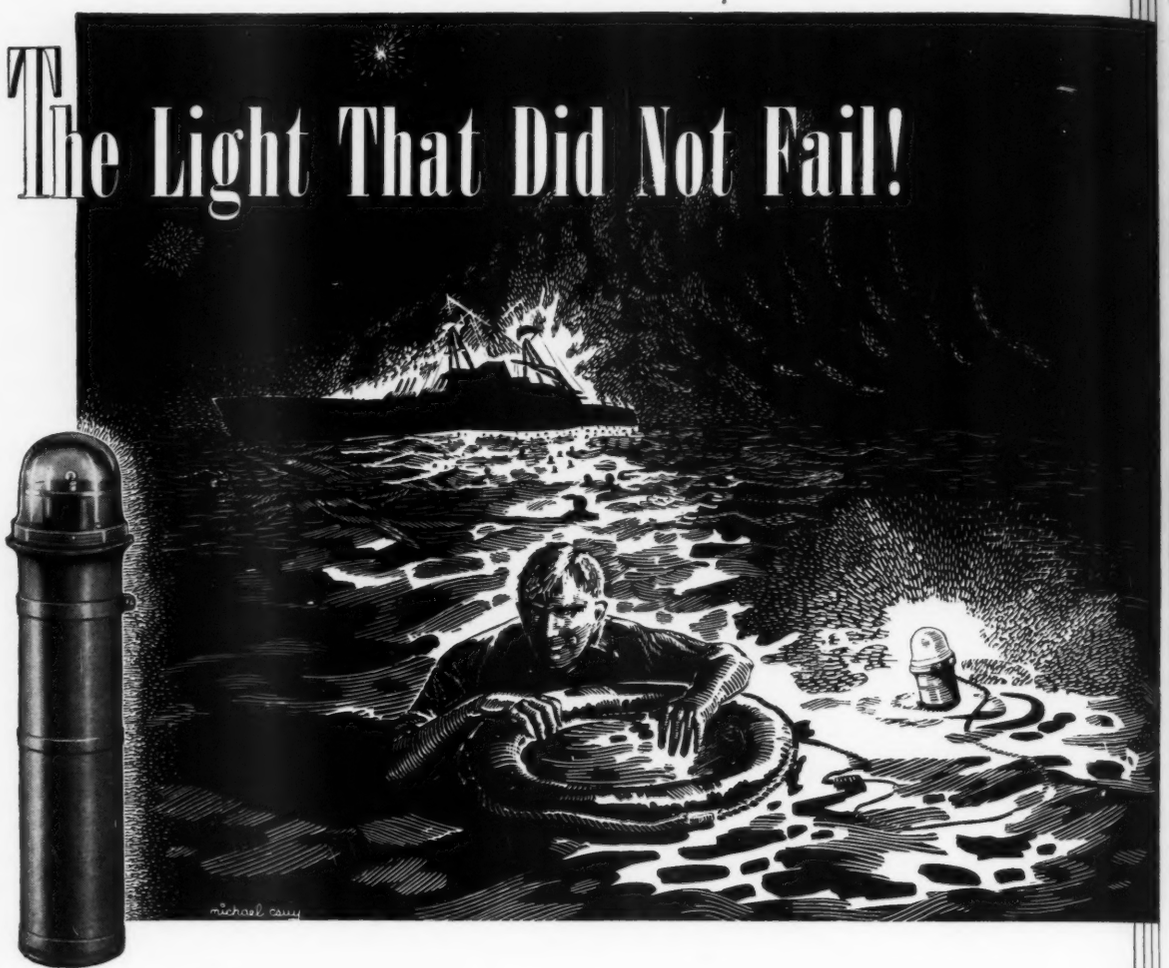
WALL·COLMONOY CORPORATION

720 Fisher Building · Detroit 2, Michigan

The Light That Did Not Fail!



AN important advance in Marine lighting is a new electric water light, used in conjunction with the life preservers and life raft equipment of our Coast Guard and Merchant Marine.

Erie Resistor engineers, in collaboration with the Coston Supply Company, succeeded in developing this new life saving device by using injection molded plastics for the greater part of the unit.

Formerly made of metal, the barrel is now injection molded of grey cellulose acetate butyrate, and the cap or dome is molded of clear hiacetyl acetate, reducing the weight of complete light to a little over three pounds, or about one fifth the weight of the usual water light.

The dome, formerly machined to produce a tight fit on plastics barrel, has threads molded to very close tolerance, and together with rubber gasket, makes it absolutely water proof.

This water light is an example of how Erie Resistor combines the experienced talents of their Engineering and Molding Departments to produce molded plastic articles of mechanical strength and dimensional accuracy. Write for illustrated bulletin describing Erie Resistor Plastic Molding Facilities.

Back The Attack—With War Bonds

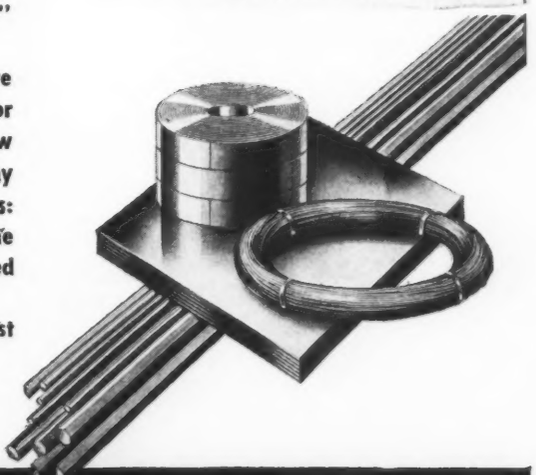
ER *Plastics Division* ER

ERIE RESISTOR CORPORATION, ERIE, PA.

When the flame and crash of battle are replaced by the tolling of bells and the roar of happy crowds, industry will be confronted with the question, "What now?" Are you ready for that day?

Though our capacity is, at present, devoted to the winning of the war, we are able to assist you at this time in the development and improvement of products for post-war use. Avail yourself of the services of our technical staff. It may show you how it is possible to improve the performance of your post-war products by taking advantage of the extraordinary properties of these vital Riverside alloys: Phosphor Bronze, Nickel Silver and Beryllium Copper. To such a service we bring the collective ability, experience and facilities of an organization which has specialized in the production of these engineering materials for many years.

Please send your inquiries to our main office at Riverside, N. J. or to our nearest branch office.



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BERYLLIUM COPPER • PHOSPHOR BRONZE • NICKEL SILVER

Sheet Strip Wire Rod

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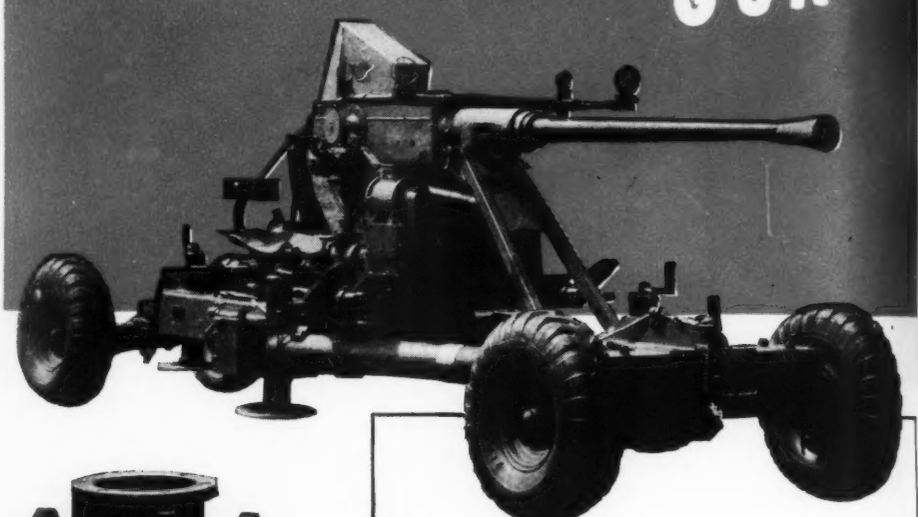
Meehanite—

replaces scarce metals in—

BOFORS ANTI-AIRCRAFT GUN

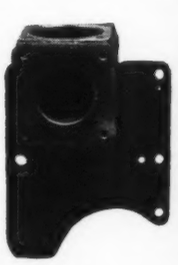


This 28-pound Gear Case, formerly made of manganese bronze, is now produced in Meehanite.

To conserve strategic metals, Meehanite Castings have replaced manganese and tin bronze in some 20 parts of the Bofors Anti-Aircraft Gun without reducing the effectiveness of the gun in any way. The economy, reliability and versatility of Meehanite, find many wartime jobs for this material.

Write for details today.

Top Gear Box, containing gears for training mechanism, was also made of manganese bronze. High strength (55,000 p.s.i.) Meehanite now used.



82 pounds of much-needed tin bronze were saved, per gun, by using Meehanite for Main Body Elevating Gear Boxes.

MEEHANITE RESEARCH INSTITUTE

New Rochelle, New York

...are Deepfreeze Chilling Machines Used for the Cold Treatment of Metals?

What are the Latest Facts About the Use of Sub-Zero Temperatures?

How Can You Use Sub-Zero Temperatures in Your Plant?

Get the answers in this new

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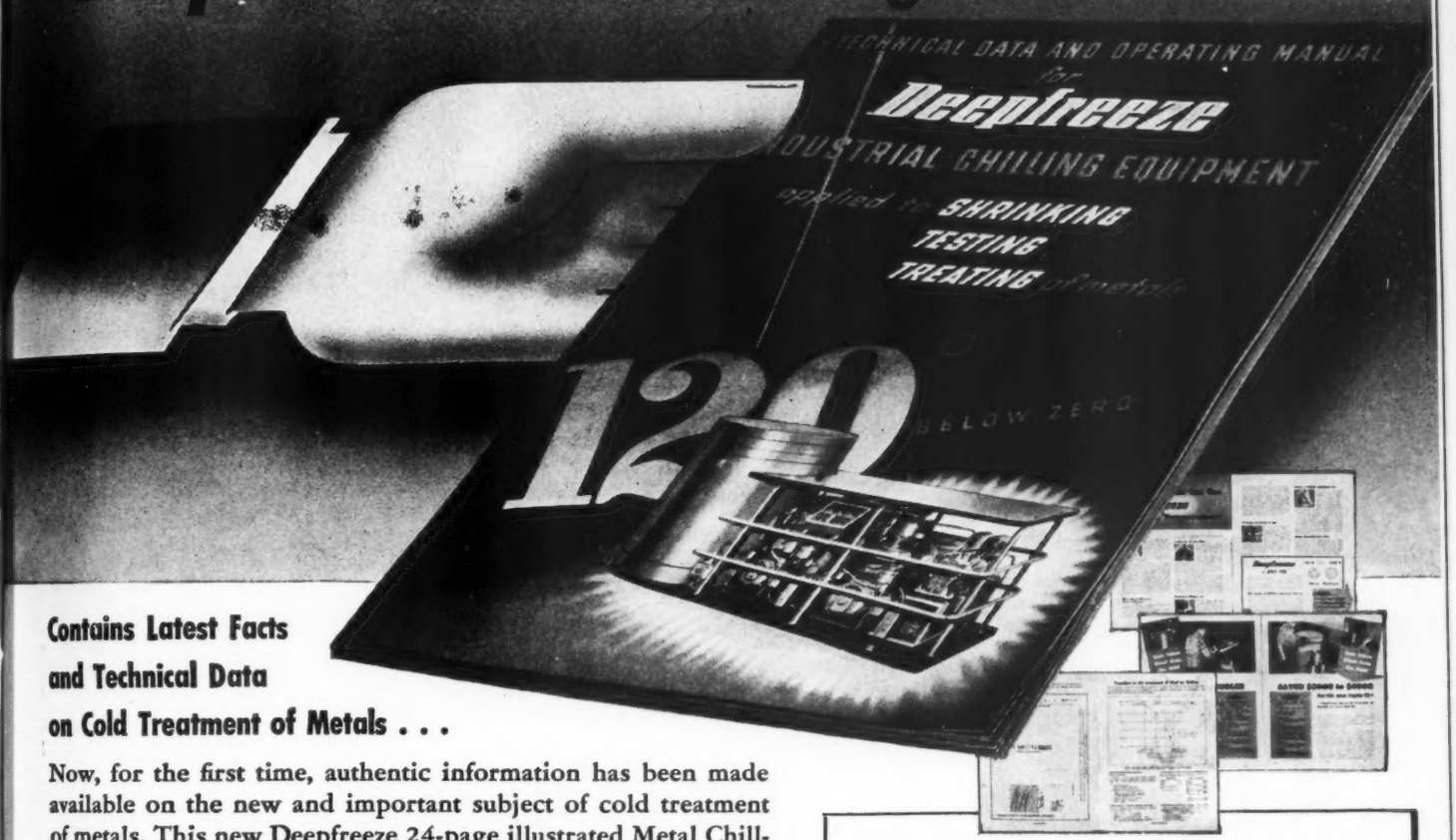
Deepfreeze Metal Chilling Data Book



Contains Latest Facts and Technical Data on Cold Treatment of Metals . . .

Now, for the first time, authentic information has been made available on the new and important subject of cold treatment of metals. This new Deepfreeze 24-page illustrated Metal Chilling Data Book contains the latest information and technical data on the application of Deepfreeze Industrial Chilling Machines.

In this handy working guide on the use of industry's newest production tool you can learn how to use sub-zero temperatures for the shrinking, testing, hardening and stabilization of metals in your plant.

Get Your Free Copy Today—Every executive concerned with the "conditioning" of metals should have a copy of this new book. Whether you have a problem in metal shrinking, treating or testing, or whether you are not sure if Deepfreeze sub-zero temperatures can be applied to your manufacturing, this new book can be of value to you. A free copy can be obtained by writing Deepfreeze, North Chicago, Illinois. Write today for as many copies as you need.

24 Pages of Technical Data, Tables, and Other Valuable Facts

These are just a few of the things you will find out in this book about the cold treatment of metals:

I—How cold treatment is used to harden and stabilize high speed, moly-type and other steels.

II—How to calculate the rate of production obtained in reducing the temperature of a quantity of work to a specified temperature.

III—How one manufacturer saved $3,000 to $4,000 per month over liquid air in a shrink-fit assembly.

IV—How chilling in a Deepfreeze prevents expansion and growth of precision gauges.

Deepfreeze

TRADE MARK DEEPFREEZE REGISTERED UNITED STATES PATENT OFFICE

Industrial Chilling Equipment for Shrinking, Testing, Hardening and Stabilizing Metals

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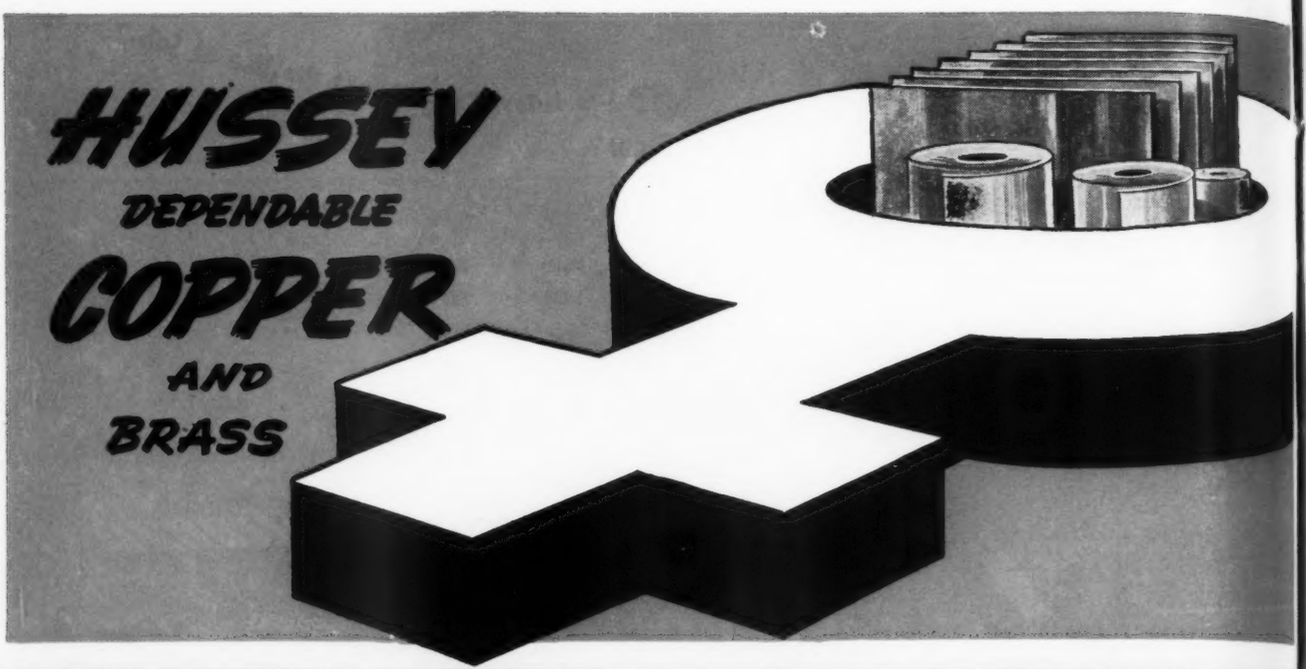
NORTH CHICAGO, ILLINOIS

Division of Motor Products Corporation, Detroit, Michigan



A GOOD NAME TO REMEMBER IN YOUR POST-WAR THINKING FOR THESE AND HUNDREDS OF OTHER SIMILAR APPLICATIONS

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Firearms
Fire Extinguishers
General Machinery
Hardware
Heating & Cooking Apparatus
Instruments
Laundry Equipment
Lighting Equipment
Locomotives
Machine Tools
Mechanical Power Trans. Equip.
Mining Equipment
Motorcycles, Bicycles, & Parts
Motor-Vehicles & Parts
Oil Burners
Oil Field Equipment
Photographic Apparatus
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and hundreds of other similar applications where the corrosive action and easy workability and dependability of copper and brass are essential.

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C. G. HUSSEY & COMPANY
(DIVISION OF COPPER RANGE CO.)
Rolling Mills and General Offices: Pittsburgh, Pa.
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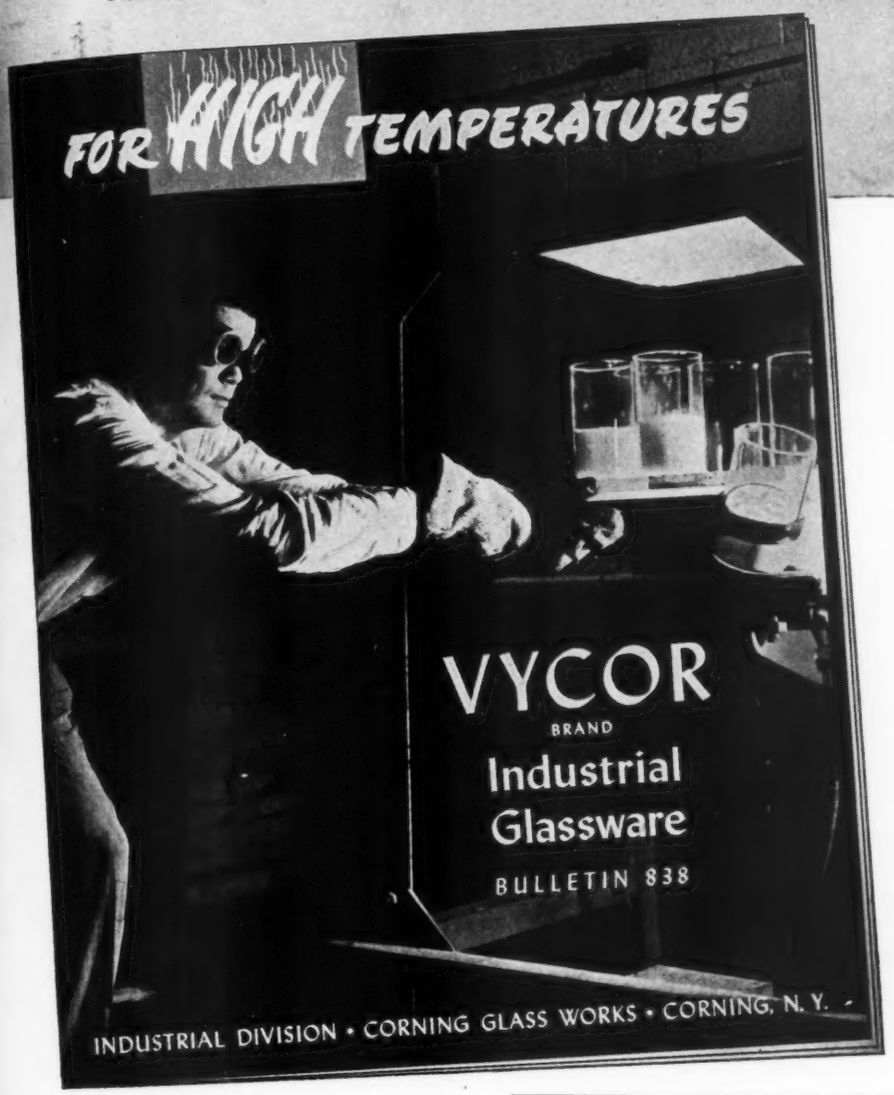
You want to know *All* the facts on VYCOR BRAND INDUSTRIAL GLASSWARE



This New Bulletin Tells:

1—What You Should Know About 96% Silica Glass No. 790:

Composition . . . Manufacture . . . Chemical Stability . . . Physical Properties and Maximum Operating Temperatures.

2—What is Available Now in 96% Silica Glass No. 790:

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Write to Industrial Division, Dept. PE2, Corning Glass Works, Corning, N. Y., or mail the coupon below.

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Vycor Industrial Glassware
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Design the Future
IN STAINLESS STEEL

Making its bid as the family runabout of the future is a new type of aircraft . . . a craft that can land on a garage driveway, fly in reverse or sideways as well as forward, or hover indefinitely over one spot . . . the helicopter. Its possibilities are already challenging aircraft designers.

The propeller or rotor serves as the wings, producing lift by horizontal rotation. Obviously, the propeller blades must be exceptionally strong, yet light in weight. The body must be sturdy enough to take the shock of vertical landings. The material specified for the construction of helicopters, therefore, must resist wear and impact, and corrosion from weather and water, while maintaining a high strength-weight ratio. Stainless steel fulfills all of these requirements, and has lasting beauty as well.

Are you designing a new product to compete in postwar markets? Or, are you streamlining an old product for renewed competition? If so, plan your future with stainless steel. Today, stainless steel is important in war work. When the war is over, it will be available to make your blueprints reality.

We do not make stainless steel, but we produce the alloys used in steelmaking. Our metallurgists have a background of over 35 years' experience with stainless and other alloy steels. If you have a problem in the selection, fabrication, or use of alloy steels, consult us.

BUY UNITED STATES WAR BONDS AND STAMPS

ELECTRO METALLURGICAL COMPANY
Unit of Union Carbide and Carbon Corporation
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In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario

Electromet
Trade Mark
Ferro-Alloys & Metals

That they may *breathe and live and fight*

OXYGEN TANKS OF

N·A·X 9115 ALLOY STEEL

Up in rarefied, sub-zero skies, the lives of aviators and air-borne wounded depend on the oxygen tank—an item in which steel requirements are especially severe and complex.

Here, the metal must be *tough* with tensile strength to withstand high operating pressures and take the impact of gun fire without shattering . . . yet weight restrictions necessitate the use of a comparatively light gauge sheet, and critical steel making alloys have to be conserved.

In addition to these specifications, the steel has to have the properties necessary for atomic hydrogen arc welding on fully automatic equipment.

This difficult and important problem has been solved successfully by Chambers Corporation of Shelbyville, Indiana. They spent over a year in development work, and they selected N-A-X 9115 Alloy Steel as their basic material . . . Write for our new book on N-A-X 9100 Series Steel. It may help you solve other vital problems.

DUCTILITY — ITS INHERENTLY FINER GRAIN MAKES ALL THE DIFFERENCE — STRENGTH

GREAT LAKES STEEL CORPORATION

DETROIT, MICHIGAN

Sales Offices in Principal Cities

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NATIONAL STEEL CORPORATION

Use this Data to Help You

Compensate Errors Resulting from Temperature Variations in Service

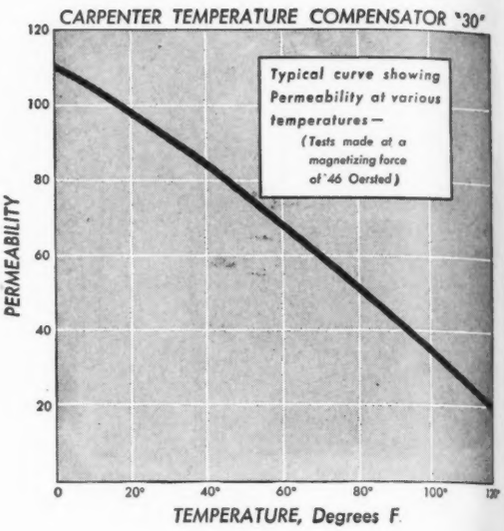
In electrical devices such as tachometers, speedometers, voltage regulators, etc., temperature compensation by the magnetic method has become relatively easy.

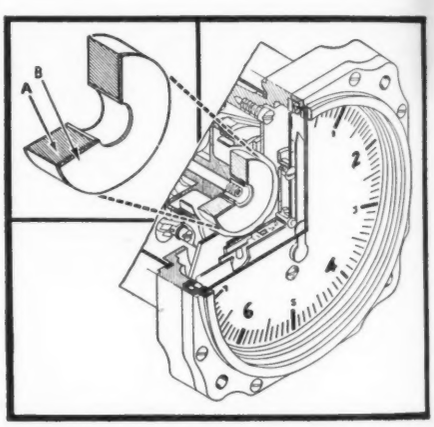
CARPENTER TEMPERATURE COMPENSATOR "30" is so made that its magnetic permeability decreases proportionally with increasing temperature, within the range of usual atmospheric temperature variation. Upon cooling, this alloy regains magnetic permeability at exactly the same rate. Thus, for each temperature there is an unchanging permeability value.

The successful use of such an alloy depends to a large extent upon ability to control and duplicate its temperature-permeability characteristics. We have therefore established pioneering methods of analysis control, coupled with routine magnetic tests of every shipment of Carpenter Temperature Compensator "30".

For cooperation in applying this iron-nickel alloy to the solution of your design-engineering problem, take advantage of Carpenter's diversified experience. Our Metallurgical Department can provide useful information about the various types of Carpenter Temperature Compensator "30"—and will gladly combine its experience with that of your engineering staff.

The properties of *Carpenter Temperature Compensator "30"* are described in detail in our latest technical bulletin. A note on your company letterhead will start a copy on its way to you. Send for it today.



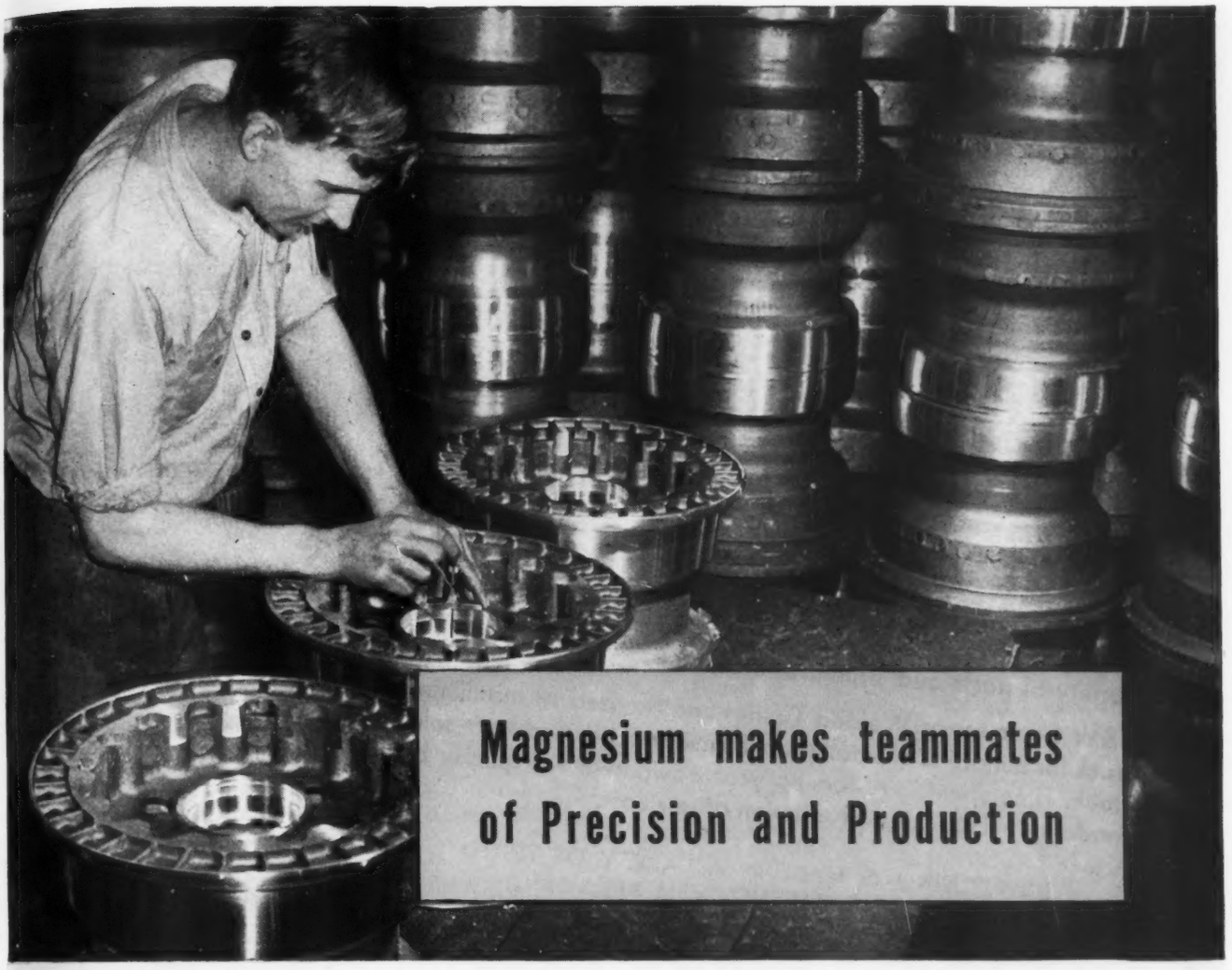


Diagrammatic view of an aircraft tachometer, showing rotating magnet (A); and shunt (B) made of Carpenter Temperature Compensator "30".

The Carpenter Steel Company, 117 W. Bern Street, Reading, Pa.

Carpenter
High Nickel Alloys

- Temperature Compensator "30"
- Carpenter Invar "36"
- Carpenter Free-Cut Invar "36"
- Glass Sealing "42"
- High Permeability "49"



Magnesium makes teammates of Precision and Production

Magnesium machines at *very high* speeds, taking a fine finish which makes extreme accuracy possible. Machine work can be held to close tolerances, therefore, even while boosting the speed of production. Think what this means to producers of vital war materials!

American Magnesium products, supplied to these manufacturers, add another plus which also helps speed this production. Their high quality—soundness and uniformity—causes Mazlo Magnesium Products, like the airplane wheels pictured above, to go through manufacturing lines a'sailing. High production schedules are easier to maintain.

Peacetime users of magnesium will profit similarly by depending upon American Magnesium as their source of supply. Our engineers, with more than twenty years experience in working with magnesium, can render valuable assistance in the design and fabrication of magnesium parts. For such help, write American Magnesium Corporation, 1702 Gulf Building, Pittsburgh, Pennsylvania.

Send for the new book, "Designing with Magnesium."

MAGNESIUM MAZLO PRODUCTS

REG. U.S. PAT. OFF.

AMERICAN MAGNESIUM CORPORATION

SUBSIDIARY OF ALUMINUM COMPANY OF AMERICA

Make it with TUBING

The pressure under which American industry is working to keep abreast of the demands for war materials has emphasized the need for time, labor and cost saving in mechanical operations. Babcock & Wilcox Seamless and Welded Steel Tubing has aided this economy by its ready adaptation to a wide variety of parts and structural uses.

B&W Seamless or Welded Tubing can be used as machining stock for hundreds of small parts formerly processed from solid stock. Time spent in re-tooling your equipment will quickly be made up in increased production at low cost.

B&W TUBING IS MADE IN A VARIETY OF TESTED STEELS. AMONG THEM ARE:

- Carbon Steels
- Carbon Molybdenum
- B&W Croloys
- S.A.E. Alloys
- High-Strength Alloys
- Stainless and Corrosion-Resisting Alloy Steel

SEAMLESS

B&W Seamless Tubing is made in a complete range of carbon and alloy steels and in sizes from ½ in. to 8⅝ in., O. D.

WELDED

B&W Resistance Welded Tubing is produced in carbon grades in sizes ranging from ¾ in. to 4 in., O. D.

THE BABCOCK & WILCOX TUBE CO.

SEAMLESS TUBE DIVISION
BEAVER FALLS, PA.

•

WELDED TUBE DIVISION
ALLIANCE, OHIO

TA-1268

NEED ANY HELP?

Ask RUSTLESS

Every day, from all over America, Canada and other countries, we are receiving many similar requests for machining information.

Because of its widespread use in war equipment, Stainless Steel is being machined by thousands who never had experience with it prior to the war. Techniques of machining Stainless differ from those used with other steels and non-ferrous metals. Through constant research, Rustless has learned many ways to increase speeds of machining, improve production and finish.

Our booklet—SHOP NOTES On The Machining of Stainless Steel—is making a real contribution to the war effort, increasing efficiency in production and conserving vital time and material.

This booklet has proved so helpful that we are receiving hundreds of requests for additional copies. Write for your copy of SHOP NOTES today and it will be mailed immediately. If you have a specific problem, call our nearest District Office.

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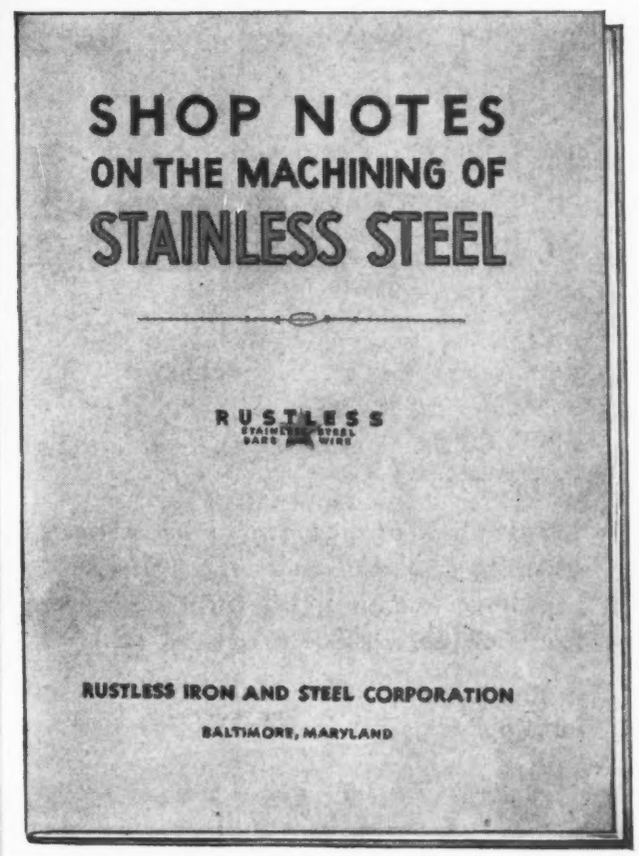

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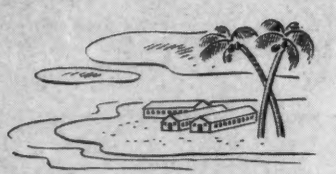

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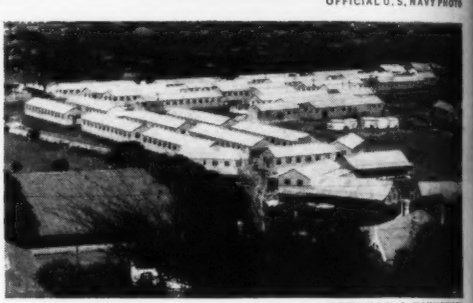

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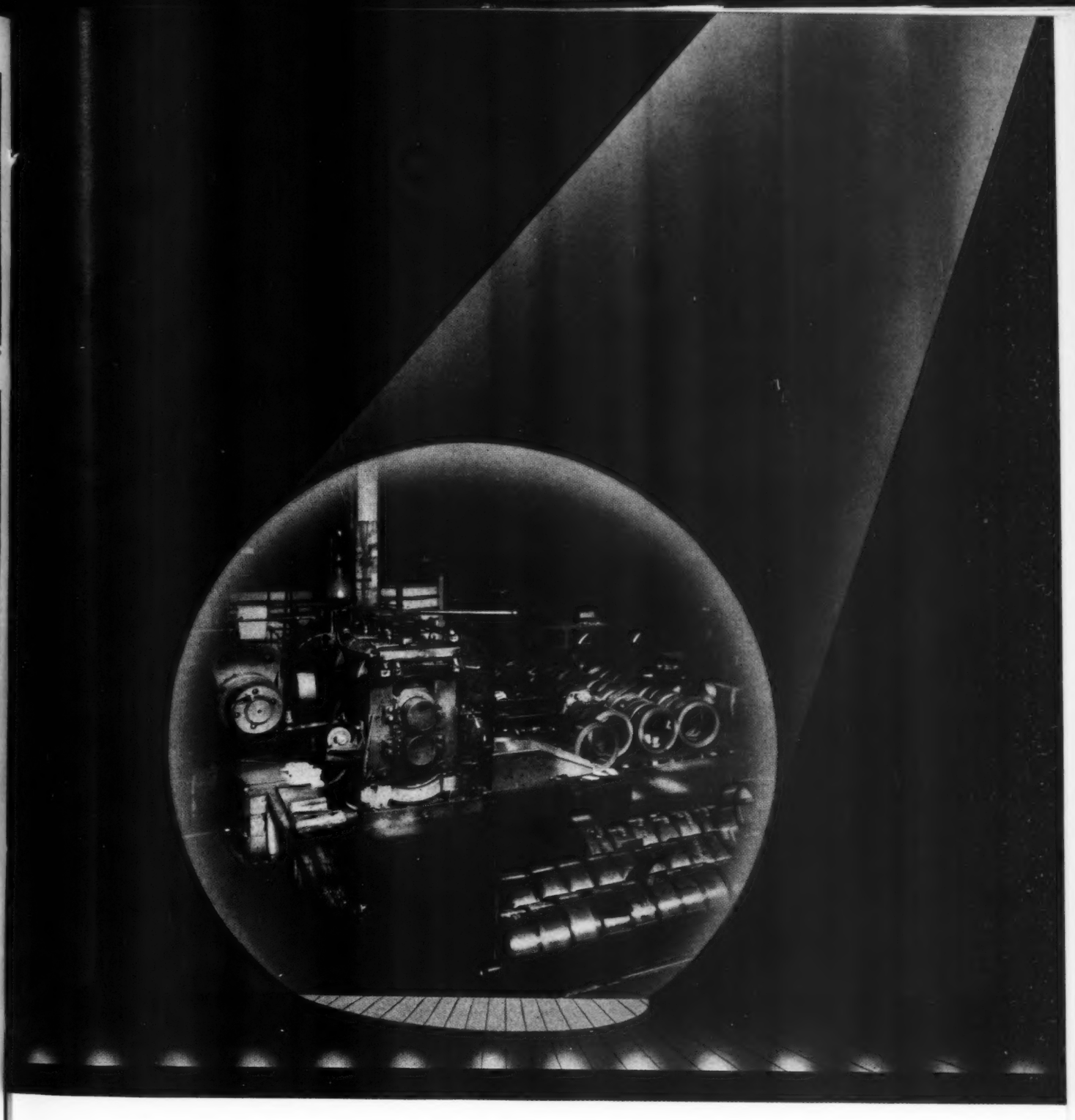

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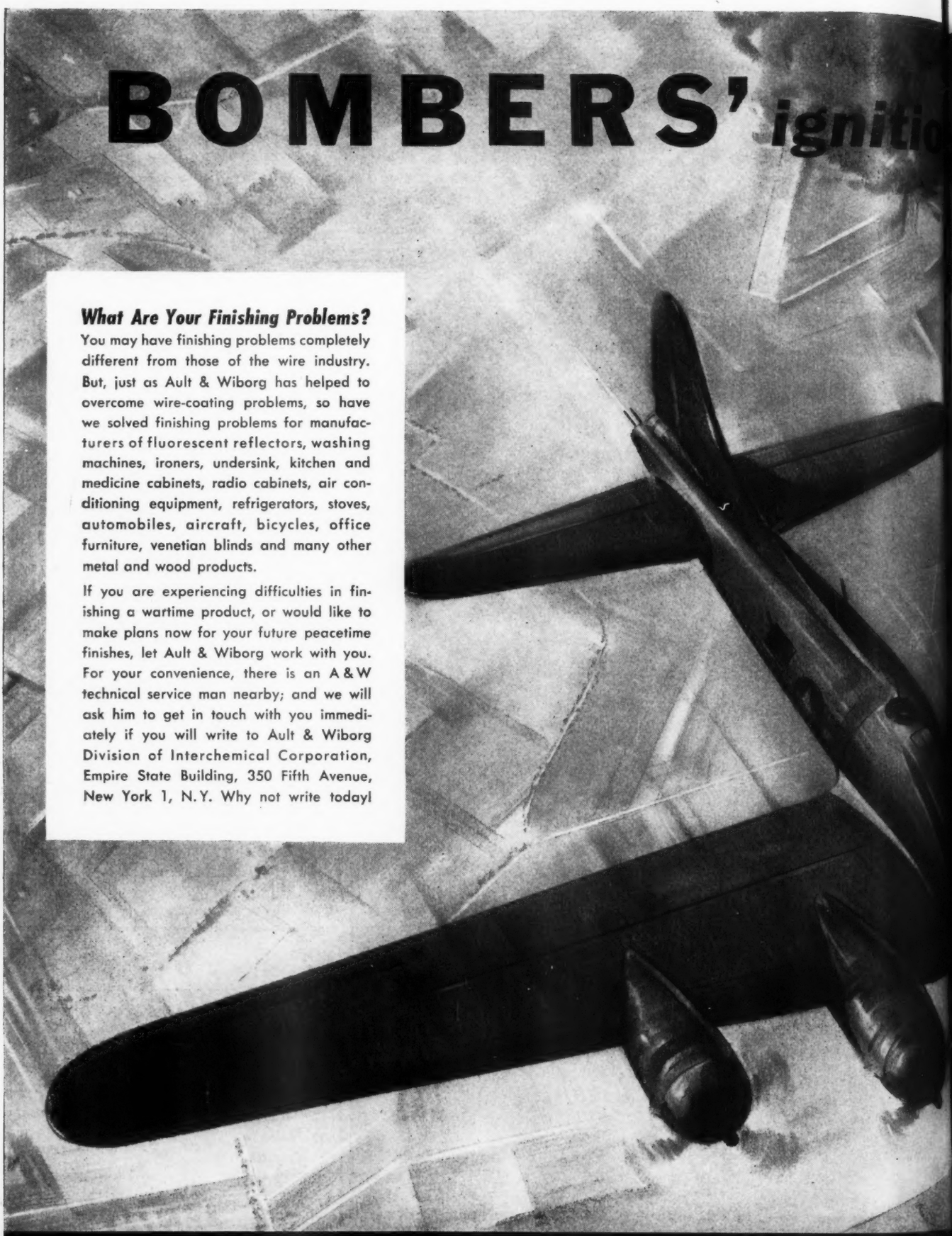

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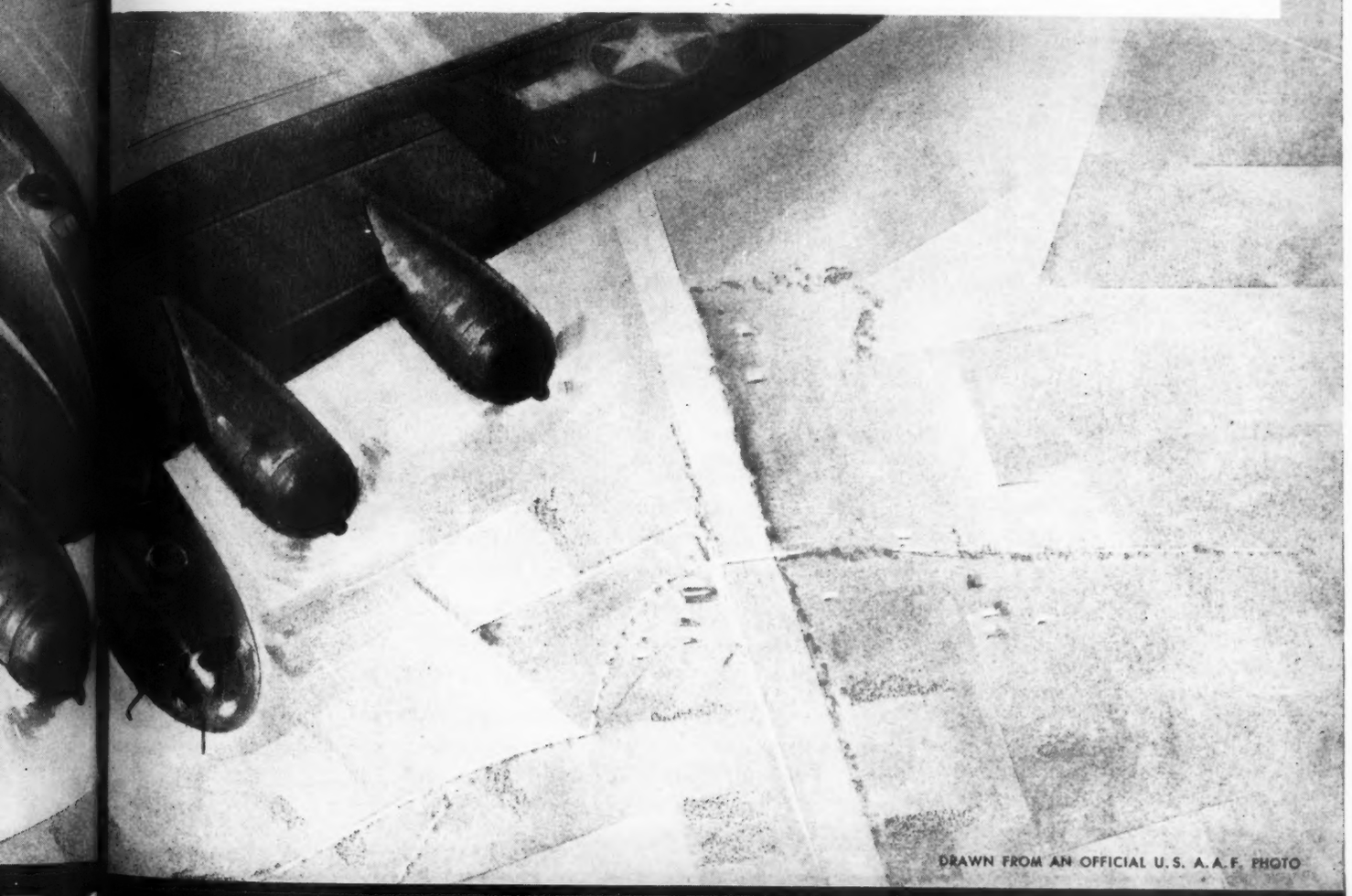

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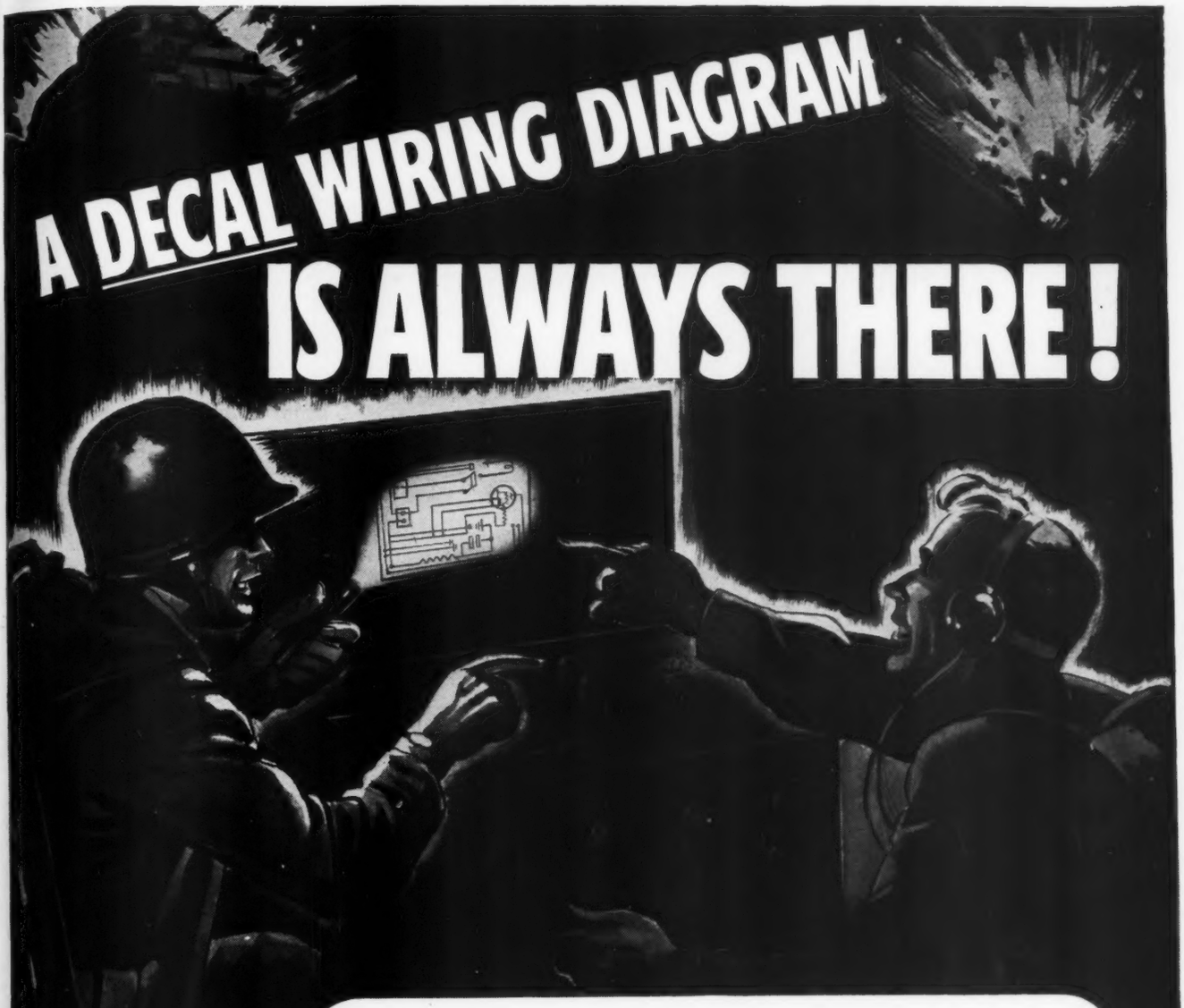

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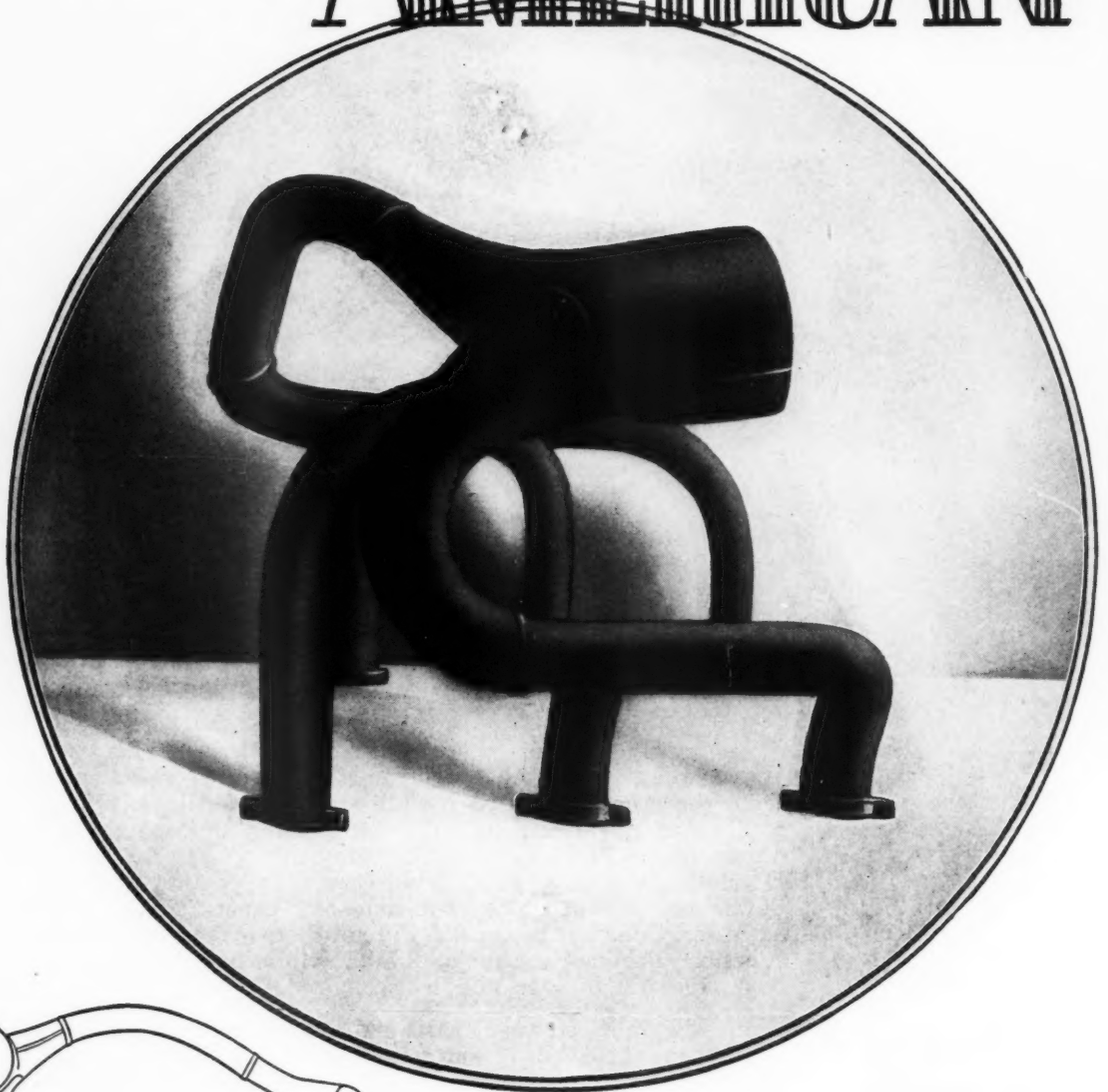

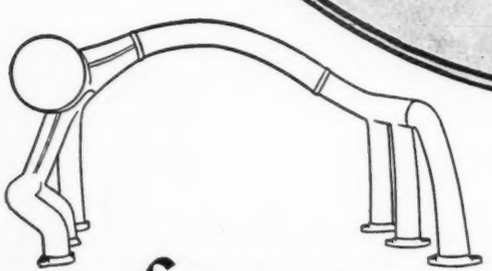

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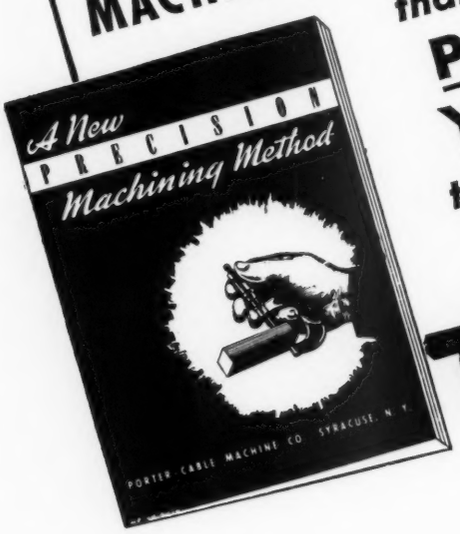

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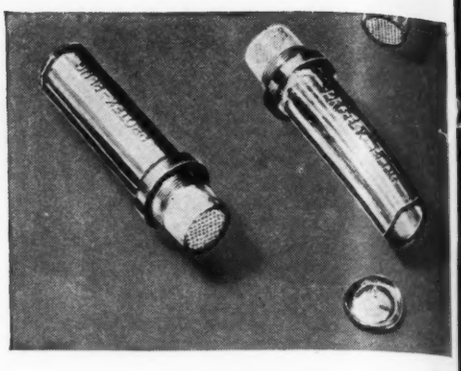

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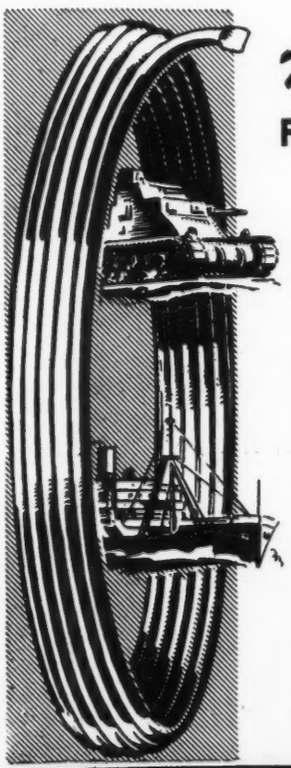

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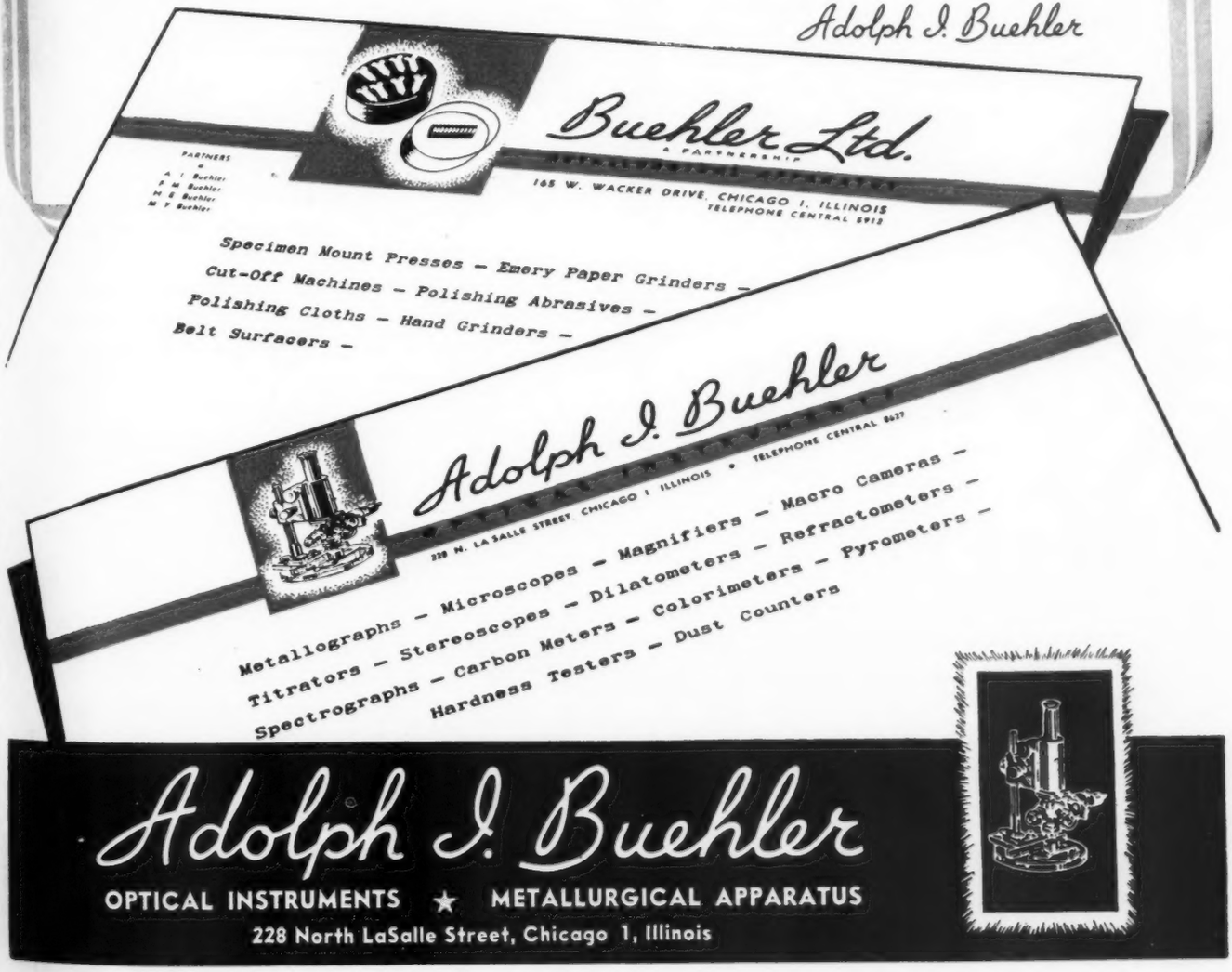
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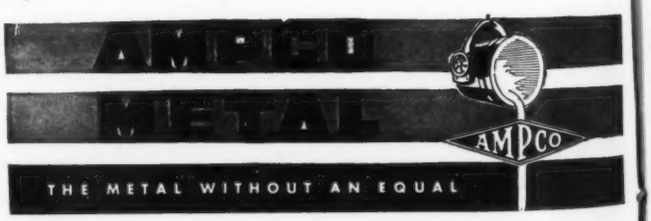

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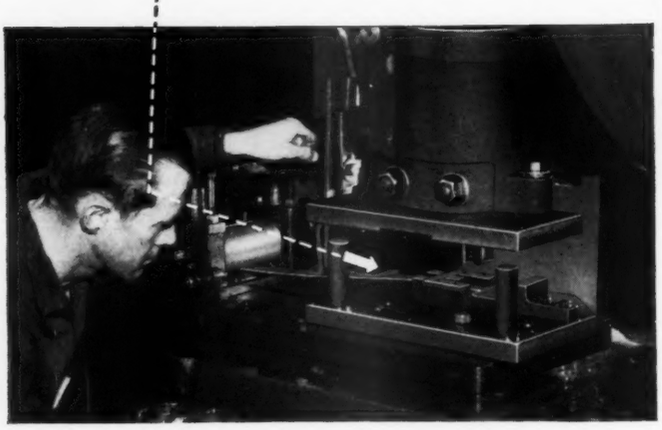

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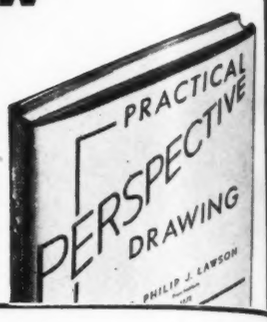

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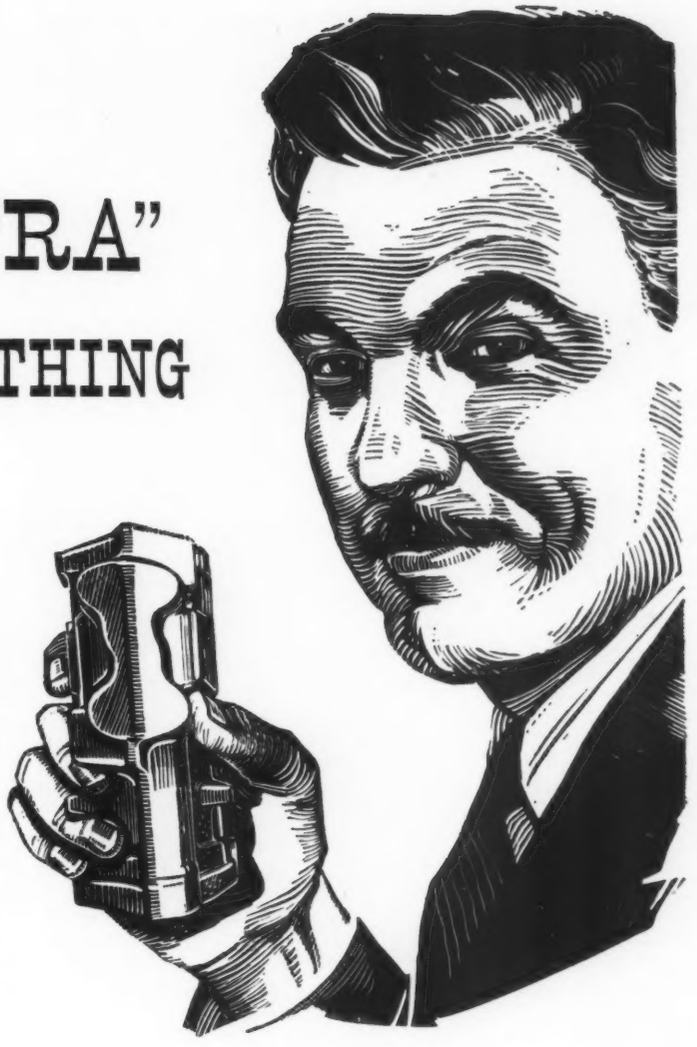


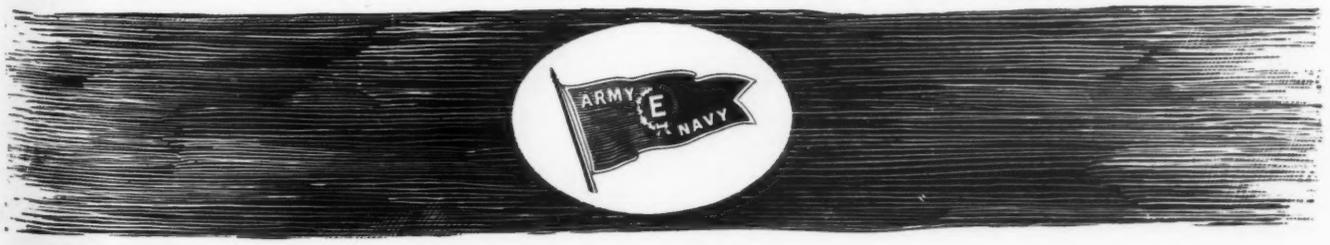
Complete industrial paint service means more than just paint. It means the practical "know how" that stops production trouble before it becomes serious. ¶ Here's an example: A customer was finishing magnesium forgings. A pre-finish was being applied that prevented proper paint adhesion. Instead of being dichromated, the forgings were chrome pickled. As a consequence, the paint film was brittle, due to poor adhesion. ¶ Telephone contact with the forging manufacturer quickly uncovered the trouble and got production going again. ¶ Further study resulted in still another production improvement... still greater adhesion and film toughness through a better balanced drying schedule. ¶ The finishing of new light metal alloys brings up new finishing problems, in the solution of which we will be glad to give you the benefit of our experience. There are many such "extras" in Berry Brothers' Industrial Paint Service which cost you nothing extra. May we tell you more about them?

BERRY BROTHERS, INC.

Quality Finishes Since 1858

INDUSTRIAL VARNISHES • ENAMELS • LACQUERS

DETROIT, MICHIGAN • WALKERVILLE, ONTARIO • JERSEY CITY • BOSTON • CINCINNATI • CHICAGO • ST. LOUIS



INDIUM

The VITAMIN for Non-Ferrous Metals

as **VITAMIN "A"** it provides non-ferrous metals and their alloys with greater tensile strength and fatigue resistance.

as **VITAMIN "B"** it protects surfaces against wear and corrosion.

as **VITAMIN "C"** it enhances high polish qualities.

as **VITAMIN "D"** it increases ductility, extrudability and spreadability.

Important military and industrial uses are being made today in each and every one of the above groups . . . many applications, in fact. And a further fact is that only a percent or two of this so-called "ounce" metal is needed in all of the above applications.

If you are fabricating from non-ferrous metals, look into the merits of INDIUM. It offers many possibilities.

THE INDIUM CORPORATION OF AMERICA

UTICA, N. Y.

New York Office: 60 East 42nd Street

G-48

Things we ought to know . . . but don't

Listening to a quiz show on the radio the other night we discovered there were a lot of things we thought we knew and ought to know . . . but somehow, didn't. That was enough to start us wondering how much our friends and customers knew about Auburn Button Works. Just to make it easy to find out we've set up a 45 second "True or False" Quiz of our own . . .

		True	False
1	Auburn Button does injection molding.		
2	Auburn can meet your requirements for plastic tubing.		
3	Auburn does compression molding.		
4	Auburn has its own die-making department.		
5	Every Auburn product must pass several inspections.		
6	Auburn does extruding of all new materials.		
7	Auburn has been molding plastics for 67 years.		
8	Auburn does transfer molding.		
9	Cellulose nitrate sheets and rods are made by Auburn.		

Your answers to all of the above should have been "True"

If you have the time drop us a card letting us know how you scored on this quiz. But whether you have time for that or not, it will pay you to take the time to drop us a line outlining your plastic requirements. Our engineers will be glad to cooperate with you in your development work.

MOLDED PLASTICS DIVISION

AUBURN BUTTON WORKS, INC.

Molders of All Types of Plastic Materials by Compression, Transfer, Injection and Extrusion Methods

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A Partial List of Industries for Which Presstite has Successfully Developed Special Sealing Compounds:

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- Sealers for—
  - Integral Fuel Tanks
  - Fuselage Seams
  - Drop-off, Expendable Fuel Tanks
  - Gun Turrets
  - Synthetic Glass
  - Instruments
  - Intercoolers
  - Air Ducts
  - Insulating Dissimilar Metals
  - Seaplane Floats

For the Refrigeration Industry:
- Sealers for Domestic and Commercial Refrigerators
- Bonding and Sealing Low Temperature Insulation in Refrigerated Rooms

For the Railroads:
- Sealers for Insulating, Soundproofing and Weatherproofing of Railway Cars — Sealing Car Windows and Spot Welded Seams

For the Building Industry:
- Roof Coatings, Caulking, and Waterproofing Compounds

For the Shipbuilding Industry:
- Insulation Adhesive and Sealers — Rust Preventive Compounds

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- Special Adhesives and Sealers

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- Sealers for Jointing Sewer Pipes
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Miscellaneous:
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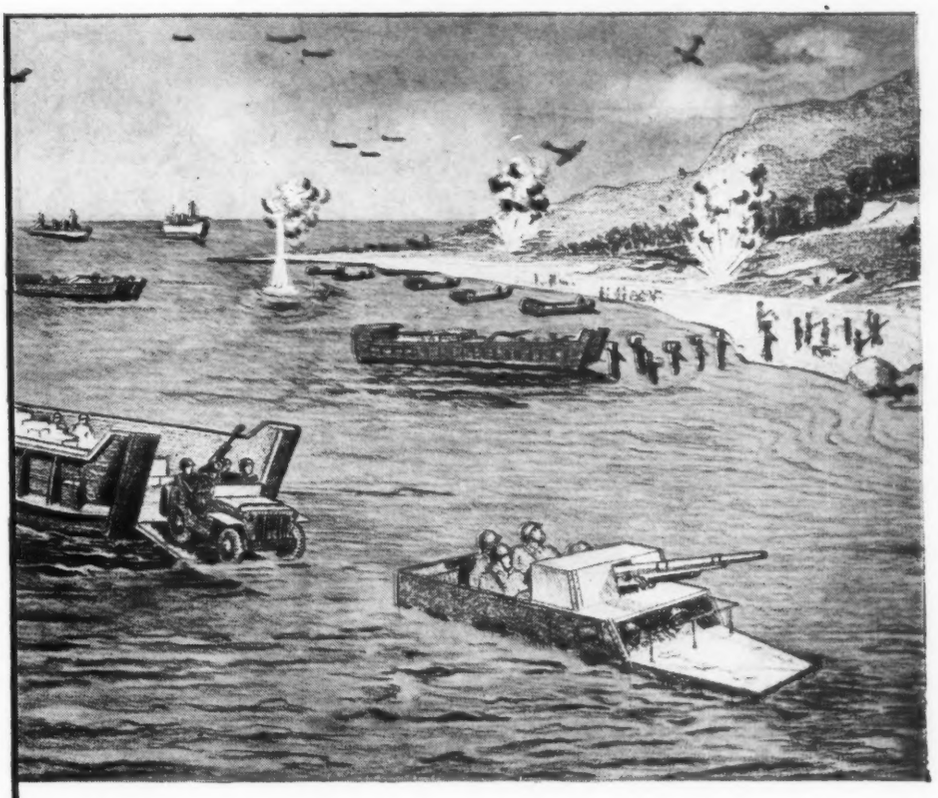
- Plus Many Special Products for the Army and Navy

Our Engineering, Technical and Laboratory facilities are at the service of any industry with a sealing problem.

PRESSTITE
SEALING COMPOUNDS



Headed for the Attack With Motors Under Water Safely Sealed With PRESSTITE Sealants

Especially developed to enable motorized vehicles to land with motors completely submerged, Presstite Sealing Compounds are now being used successfully to seal vital motor parts. Presstite Compounds seal the electrical system, as well as the joints of flexible exhaust pipe.

Presstite Compounds are also being widely used by America's leading builders of military aircraft to seal integral fuel tanks, fuselage seams, pressurized cabins, seaplane floats, gun turrets, and other essential parts and devices. They not only speed assembly, but increase the safety and efficiency of our fighting planes.

The continuing forward progress of Presstite Engineering and Research made it possible to develop these compounds to meet the emergency demands of War. Our experience, facilities, and knowledge stand ready to serve American industry whenever and wherever the most effective sealing compounds are required.

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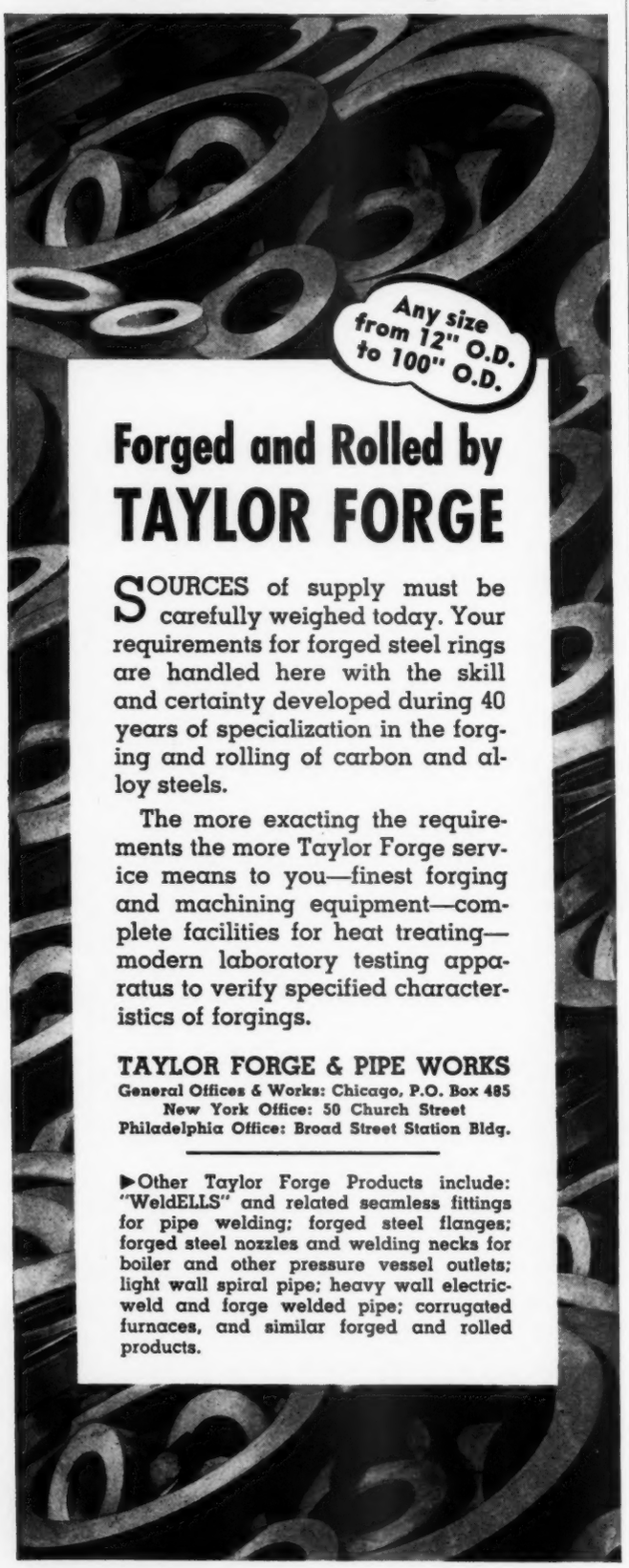
PRESSTITE ENGINEERING COMPANY, 3956 Chouteau Avenue, St. Louis, Missouri

RINGS

in carbon and alloy steels



Any size from 12" O.D. to 100" O.D.

Forged and Rolled by TAYLOR FORGE

SOURCES of supply must be carefully weighed today. Your requirements for forged steel rings are handled here with the skill and certainty developed during 40 years of specialization in the forging and rolling of carbon and alloy steels.

The more exacting the requirements the more Taylor Forge service means to you—finest forging and machining equipment—complete facilities for heat treating—modern laboratory testing apparatus to verify specified characteristics of forgings.

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▶Other Taylor Forge Products include: "WeldELLS" and related seamless fittings for pipe welding; forged steel flanges; forged steel nozzles and welding necks for boiler and other pressure vessel outlets; light wall spiral pipe; heavy wall electric-weld and forge welded pipe; corrugated furnaces, and similar forged and rolled products.

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- Does not ravel, hay, or lose its shape
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- Adheres easily to other parts.

NOW BEING USED AS:

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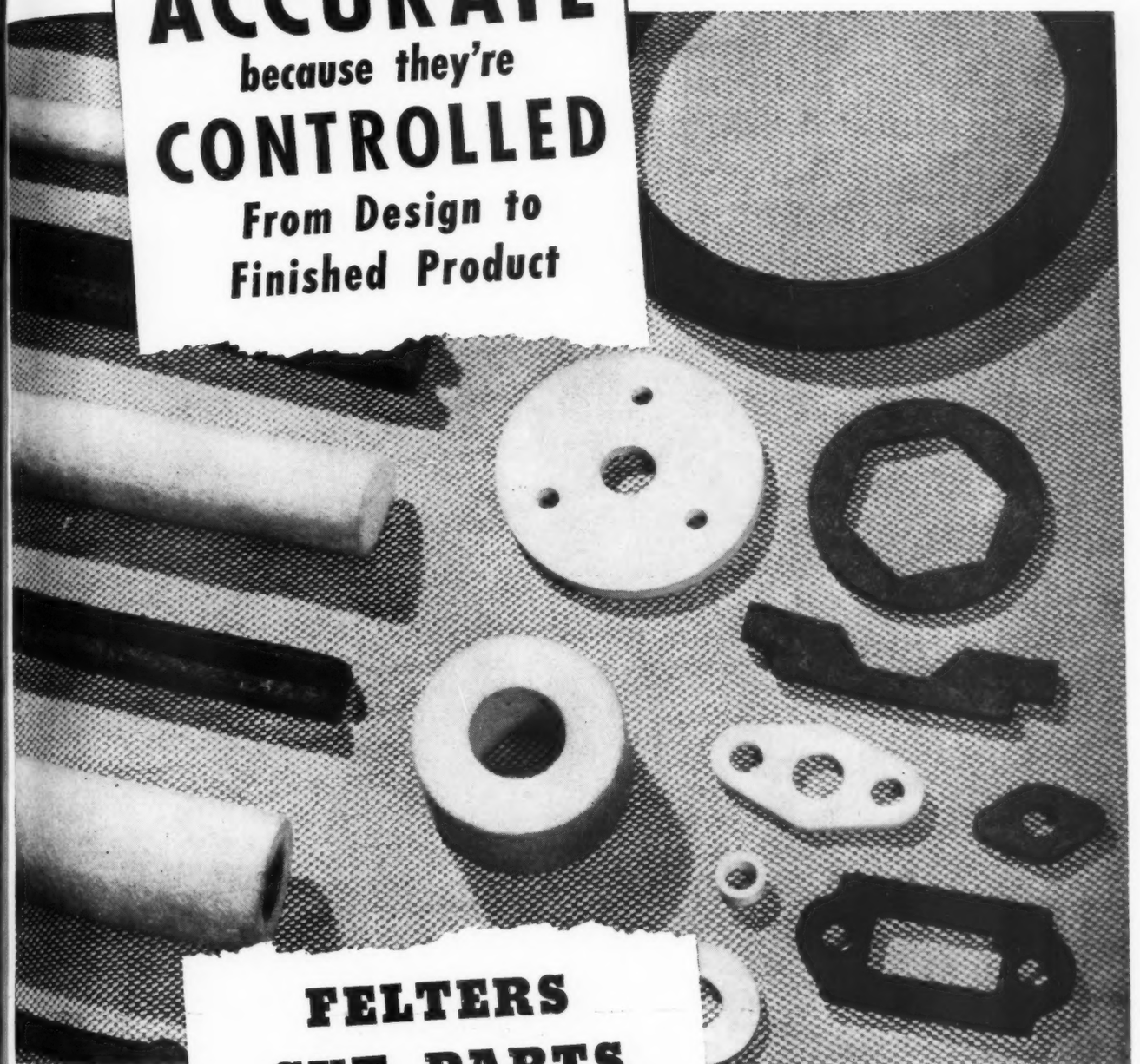
They're ACCURATE because they're CONTROLLED From Design to Finished Product



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No matter what size or shape a Felters Cut Part is, it is destined to perform an important function and therefore receives *unified control* from raw material to finished product. This step-by-step control by Felters designers, laboratory men, engineers and specialized production men *assures the accuracy* that felt cut parts must have to meet individual requirements most effectively.

Also, the experience and facilities of our designing, engineering and laboratory men are at your call, if we can help you solve some problem relating to the use of felt or felt cut parts Write.

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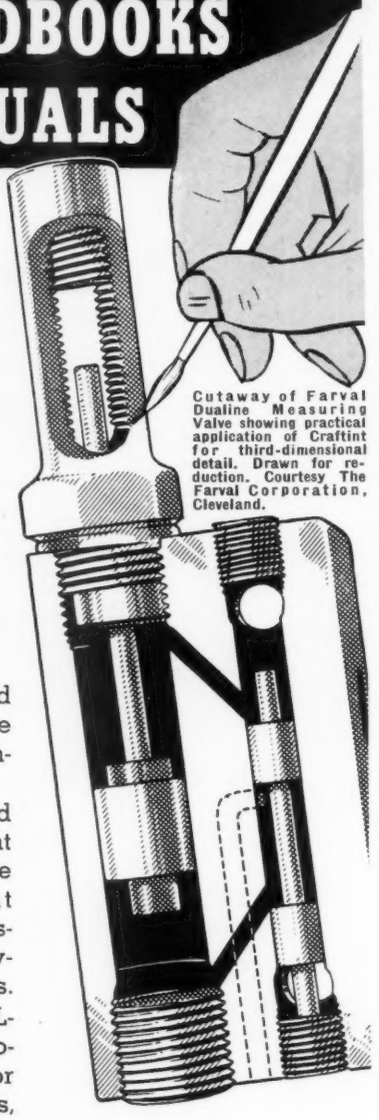
for HANDBOOKS for MANUALS



Cutaway of Farval Dualine Measuring Valve showing practical application of Craftint for third-dimensional detail. Drawn for reduction. Courtesy The Farval Corporation, Cleveland.

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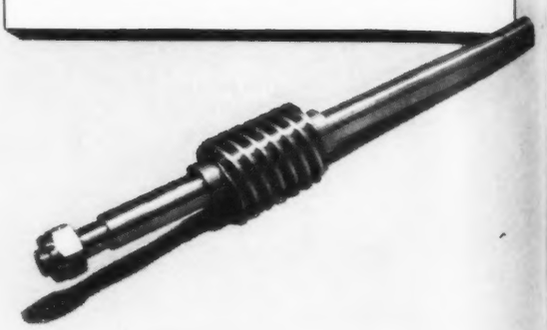
DO YOUR PLANS CALL FOR HARD STEEL PARTS?



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MACHINE STEELS UP TO 550 Brinell

Designers can increase the efficiency and performance of new equipment by specifying steels of high tensile strength for parts subject to great stress. The ability of KENNAMETAL carbide steel-cutting tools to machine these hard, tough metals permits design engineers to prescribe hard, smaller steel parts rather than heavy, thick metal of lower Brinell.

The illustrated chrome nickel worm shaft and worm was turned with a KENNAMETAL tool, style 11, with a chip breaker, at 240-300 feet per minute. The tool ran a full eight hour shift without regrinding.

The advantages of strong hard steels may be employed in your designs with the assurance that they can be machined with KENNAMETAL, the superior carbide for cutting steel. Write for KENNAMETAL Catalog 43-C containing complete information on tool selection and handling. It will help your shop men to collaborate with you in producing designs economically.

KENNAMETAL THE All American CARBIDE

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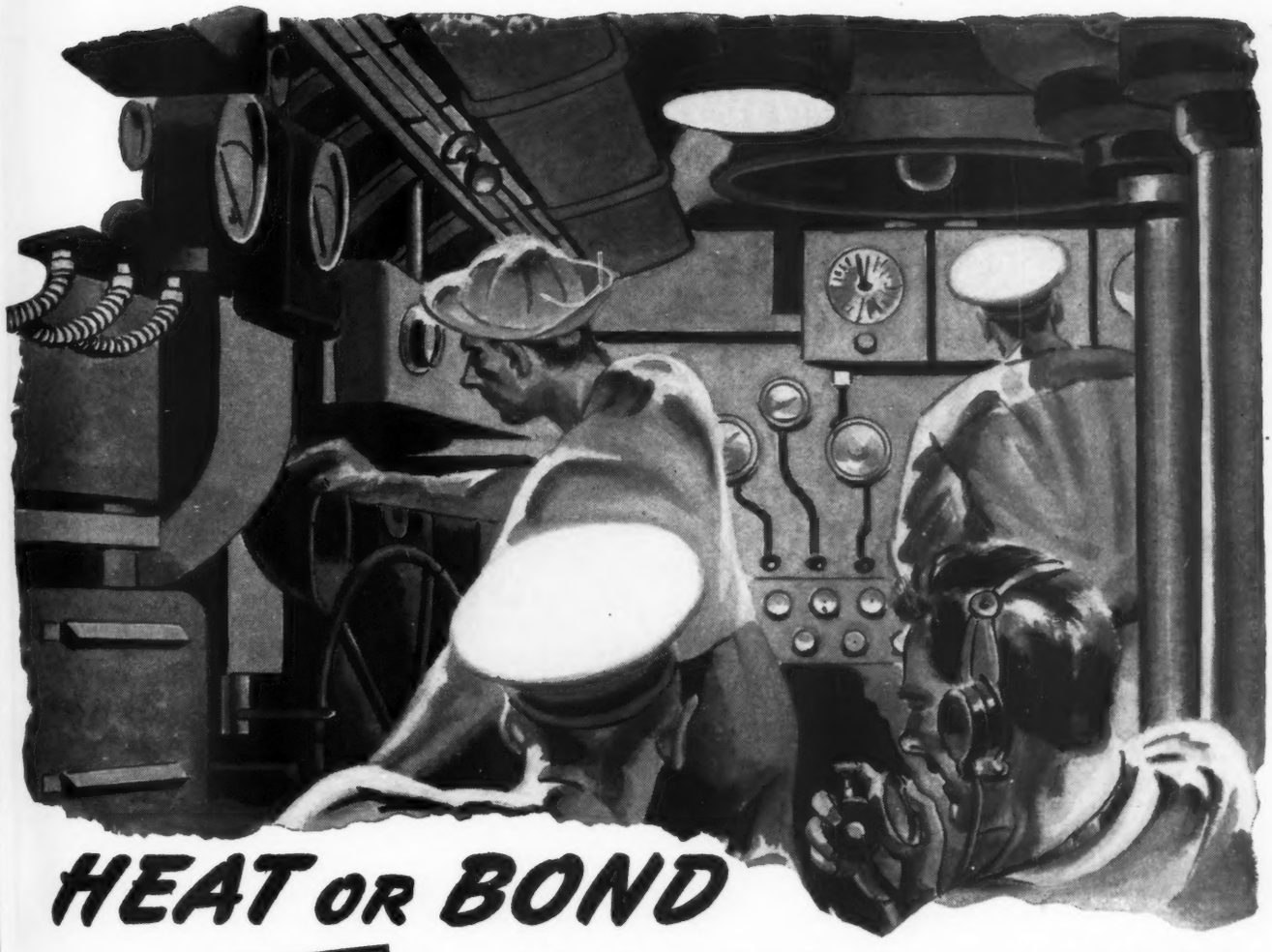
Trade Mark Reg. U. S. Pat. Off.



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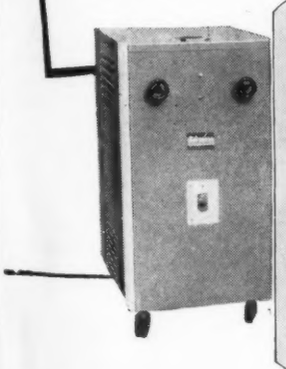

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THE GIRDLER CORPORATION

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FOR YOUR PRODUCTION NEEDS

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A straight side shop box with drop handles each end. Excellent for shop use where stacking feature is not required.

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No. 202 8" x 12" x 4" 20 ga.....$ .45 Ea.
No. 203 9" x 13½" x 4½" 19 ga.....$ .60 Ea.

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Just right for your small parts. Light in weight, easy to handle. Equipped with drop handles each end. Runners save wear on bottom of box and act as positive stacking lock.

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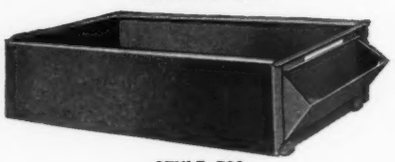

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Prices F.O.B. Factory, Phila.—Any Quantity!

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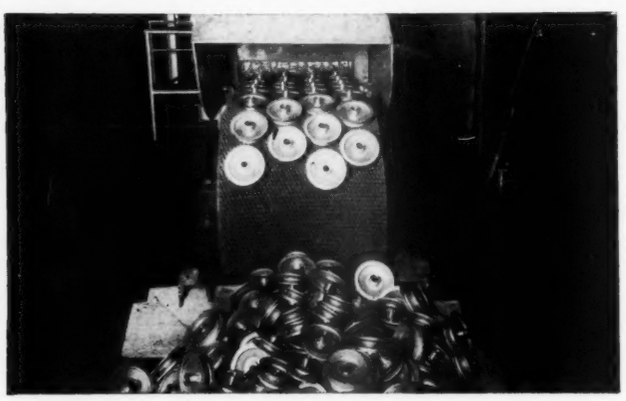

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Small assemblies weighing only a fraction of an ounce, as well as large intricate assemblies weighing several pounds are neatly and securely joined in numerous designs of continuous and batch type copper brazing furnaces—built by The Electric Furnace Company, Salem, Ohio.

The above illustration shows the discharging end of an EF continuous, belt type furnace, brazing a three piece fan pulley assembly . . . the completed pulley comes out securely joined, clean and bright.

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We have also built a number of other interesting continuous and batch type brazing furnaces, including roller hearth and pusher types, as well as furnaces for brazing by the vacuum process. We build these furnaces in any size and for handling practically any number of pounds required per hour.

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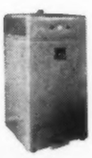
YOU CAN TRUST YOUR LIFE

-on a sheet of steel only 1/56 of an inch thick

Lindsay Structure houses this Miller Hydro Bottle Washer.

This Lindsay Structure radio equipment cabinet was assembled in less than an hour.

Due to the light weight of its Lindsay Structure housing, this fire extinguisher is easily maneuverable.



Lindsay Structure, with its "pre-tensed sheets," achieves extraordinary strength and lightness. It is quickly and easily assembled by workers without special training, and no special tools are required.

Here is a demonstration of the great strength made possible by the modern method of light steel construction—Lindsay Structure.

By utilizing the strength in light sheet metal, this 30 ft. chute made of 26 ga. sheet easily supports four men. There is no sagging! In fact, the I-Beams (arrow) with which unbelieving engineers expected to support the chute actually sag away from it under their own weight. Thus, Lindsay Structure, with its amazingly high strength-weight ratio, makes possible tremendous savings in steel. It also saves production delays and skilled labor. No special tools or equipment are required—no tooling up to handle its assembly.

For buildings, truck and trailer bodies, refrigerated boxes or rooms—for partitions, housings, and many other applications—investigate Lindsay Structure.

Lindsay Structure will render immediate service on your pilot jobs. Wire or phone for information. Lindsay and Lindsay, 222-B W. Adams St., Chicago 6, Ill.; or 60 E. 42nd St., New York 17, N. Y.

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A well-established manufacturing company in the metal field—distributing in normal times through automotive, hardware and industrial supply channels and direct to industry—we are interested in products to add to our present lines for development for after-the-war markets.

Our present production facilities include wire drawing, fabricating from wire by forming and welding, casting in steel, grey iron, malleable iron, and bronze, machining and screw machine work.

Products that would lend themselves to volume production and offer continuing repeat sales to industrial and consumer markets would be of particular interest, although capital goods would also be considered.

Civilian products or lines of products for industrial or consumer markets on which production has been curtailed or ceased during the war and which might be taken over as a line would be of interest.

Please give details in first letter and address correspondence to—

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The 4th Edition of MARKS would give you greatest value and satisfaction as that book!

Consult Marks' Handbook for data needed in routine problems of design and practice, or in investigation of special problems or branches of work. Check your methods against best accepted practice, as reflected in its 16 big sections of carefully selected and authoritative facts. Marks' Handbook covers every branch of mechanical engineering, from aeronautics to mechanical refrigeration, from power generation to welding, from metal-cutting machines to hoisting and conveying—with a profusion of concise descriptions, fundamentals, formulas, methods, tables, diagrams, etc. Here is the means of avoiding errors, saving time and trouble in procuring vital information, assuring yourself of best results in a wide variety of problems.

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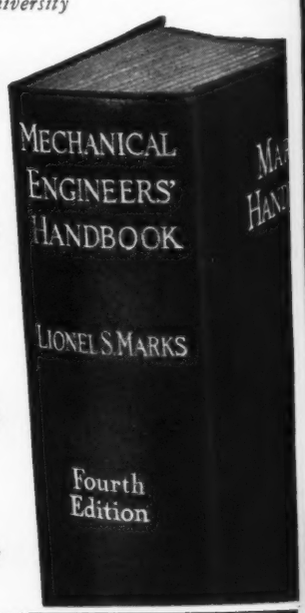

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Collaborating closely with the engineering staffs of manufacturers engaged in producing for America's military requirements, this organization has specialized in the redesign of products and parts to assure maximum benefits through the use of plastic materials and plastic molding. Our engineering experience and molding facilities will be available to serve post-war industry in similar degree; assisting in product betterment, in reducing assembly time, in lowering cost of manufacture . . . in the most practical application of plastics to products old or new. The molded plastic assemblies described below illustrate some of our precision molding and assembly services.

PM

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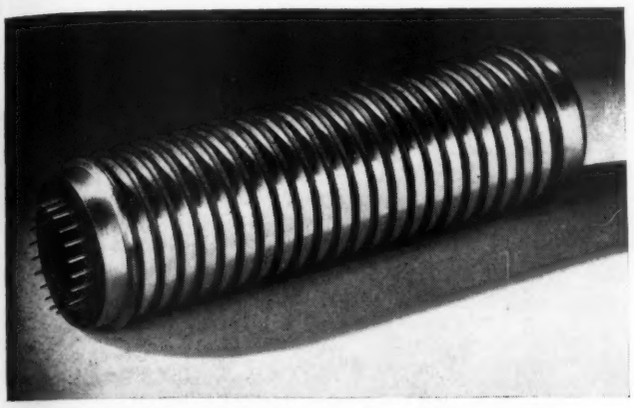

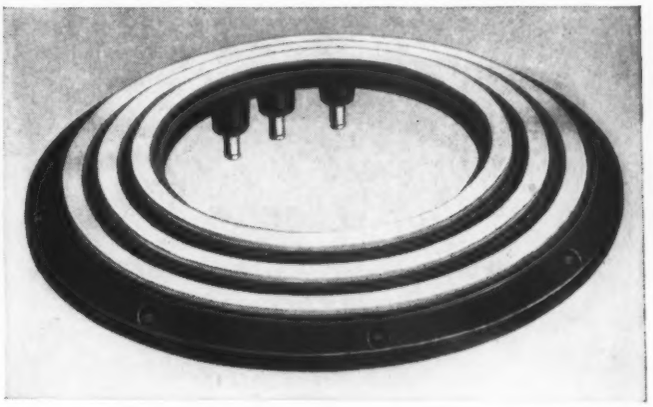

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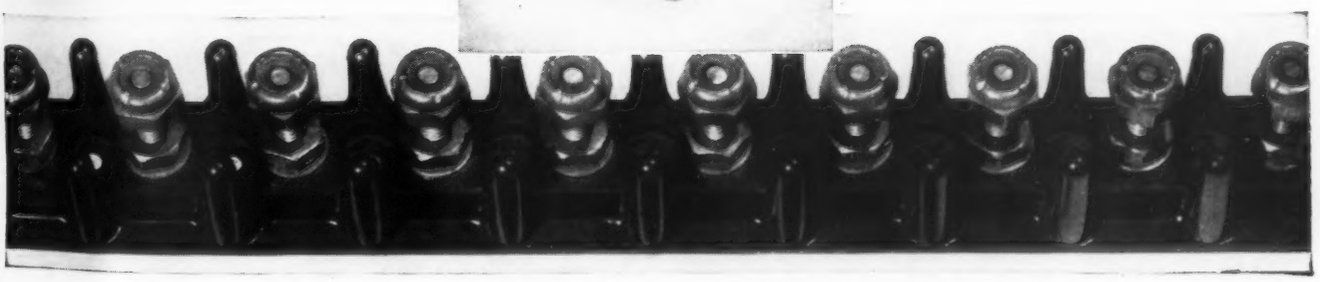
MOLDED PLASTIC ROTORS above are made in one-piece with 22 rings and 3 rings respectively. Bi-metal rings are precisely spaced and transfer-molded in a material selected by our research engineers to provide balanced physical and electrical properties. Permanent alignment is assured through one-piece construction, with consequent elimination of assembly and service problems. Our molded finish is more moisture-resistant than a machined surface with consequent reduction in power loss.

CONTROL PULLEYS . . . molded complete with ball-bearings to eliminate the need for metal bushings. This avoids variations that may occur when bearings must be fitted to bushings and saves assembly time. Mold finish of groove is smoother and harder than machined surfaces, which serves to prolong cable life. Pulleys are molded from a phenolic compound, reinforced by macerated fabric for greater durability.

MOLDED CONNECTOR PANEL ASSEMBLIES As suppliers of molded plastic parts to the aircraft industry, one of our services is the manufacture of connector panels, molded and assembled complete with hardware. These are delivered cut to desired lengths and ready for use. Assembly time is saved. Loss from scrap is avoided. The assemblies are available in 2 types: NAS 17 and NAS 18.



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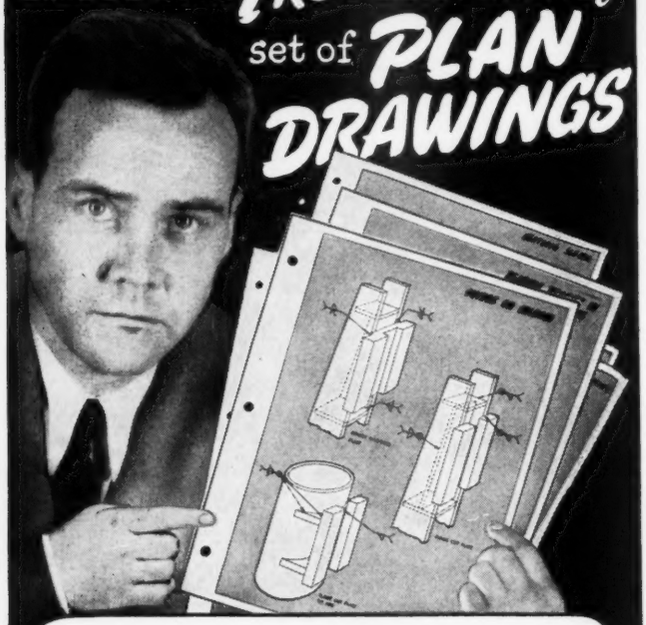
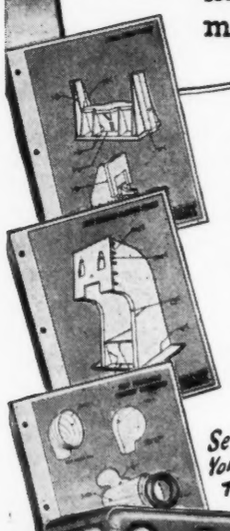


...from HOBART's "ARC WELDING DESIGN"...the service that's helping hundreds of far-seeing manufacturers.



Now, as never before, executives, engineers, and designers must use new and better methods to meet competition developing from the enormous use of welding on war production.

This Hobart service will show you many ways you can use arc welding to get better results in designing a new product or redesigning an old one—it's a very valuable compilation of actual welding experience . . . visually recorded.

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Technical Bulletin P-8 will be sent on request. Address Dept. SD.

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A company with a nationally known product would like to consider ideas and inventions suitable for post-war use in the industrial and commercial field of applying and dispensing lubricants, such as pumps, point to point, centralized lubrication, etc. Also hydraulic, vacuum, or pneumatic actuated mechanisms, pistons, valves, etc., as used in the Aircraft and Automotive field. Also passenger and industrial elevators, automatic leveling devices, controls, etc., and similar items such as portable lifting and stacking trucks or mechanisms used about factories, etc.

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SHEET, WIRE AND TUBE

meet design and performance requirements of war and peace products

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Overlay, precious metals (silver, gold, etc.) one side or both sides, any thickness.
Base metal, steel, nickel, copper, etc.
TUBING
Overlay or lined in precious metals or other corrosive resistant metals.
Base metal tubing.
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Inlays of precious metal, single or multiple.
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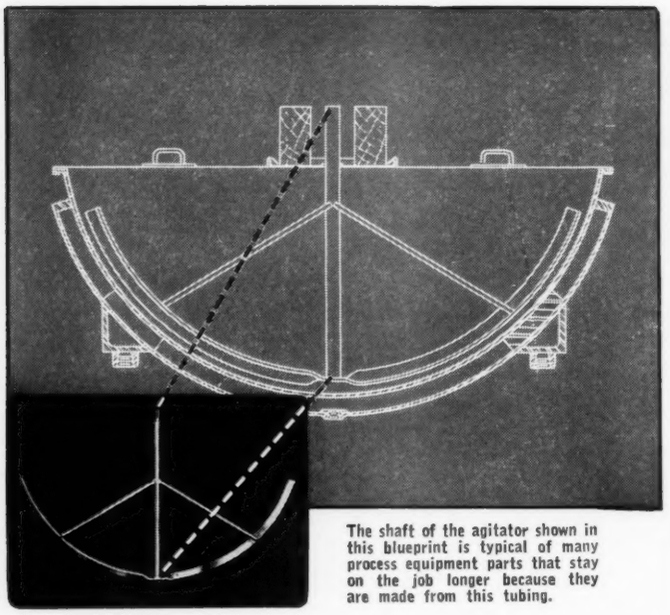

The shaft of the agitator shown in this blueprint is typical of many process equipment parts that stay on the job longer because they are made from this tubing.

Check these 5 Advantages of this Welded Stainless Tubing!

Here are five of the reasons why more and more Carpenter Welded Stainless Tubing is used in many types of processing equipment:

1. **It provides positive protection against corrosion and heat.**
2. **It helps guard against product contamination.**
3. **Easy to clean, this tubing saves time between operations.**
4. **Its high strength-weight ratio permits the use of lighter gauges for lower costs, less weight.**
5. **Uniform walls and lighter gauges mean easier bending, flanging, welding, etc.**

For help in selecting the type of Welded Stainless Tubing best suited to your needs, get in touch with our Metallurgical Department. Ever since Carpenter pioneered the development of this type of tubing, we have provided production-engineering assistance to users and fabricators.

Fabricating Hints

in Carpenter's series of QUICK FACTS bulletins can help you get the most from Welded Stainless Tubing. A note on your company letterhead will start your series of QUICK FACTS bulletins on the way.

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Welded Alloy Tube Division . . . Kenilworth, N. J.

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STAINLESS TUBING

Not Restricted, Still Low Priced

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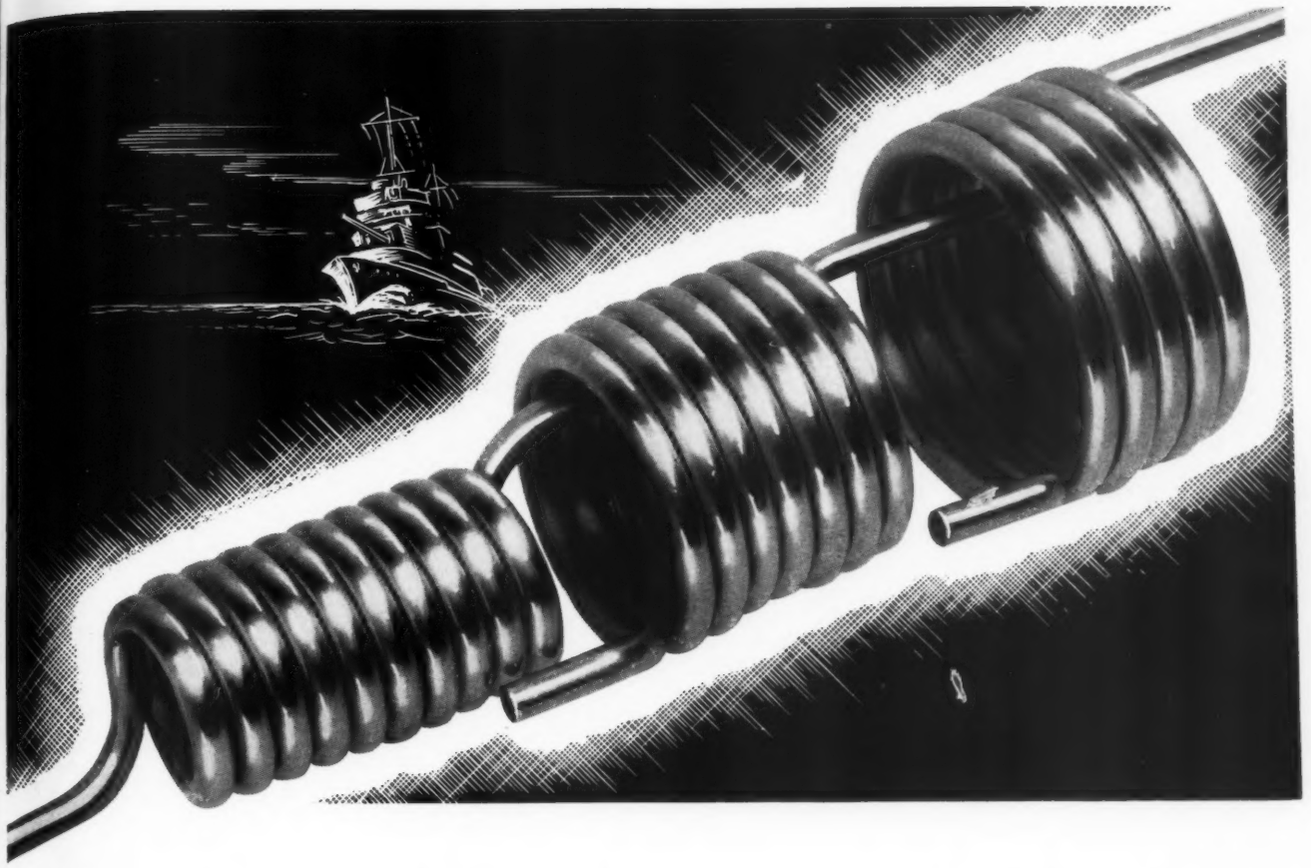

Anything like this IN YOUR PLANT?

This nested assembly of copper tube coils is fabricated to be used in an oil cooler for the Navy. It is made of tube ⅜″ outside diameter with wall thickness of .035″. Note the short radius.

If this piece reminds you of a similar problem of yours involving tube or tubular parts, call Wolverine Tube Division for consultation and quotation. We have hundreds of standard tools already on hand for making parts and assemblies similar to the part shown here, along with a wealth of experience in handling seamless tube.

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Or if you prefer to make the part yourself, call on Wolverine anyway as a source for tube that will be uniformly high in quality and possess the right properties for fabricating. Also consult our engineers regarding types of tools, methods, and techniques. Their talents and services are yours for no cost.

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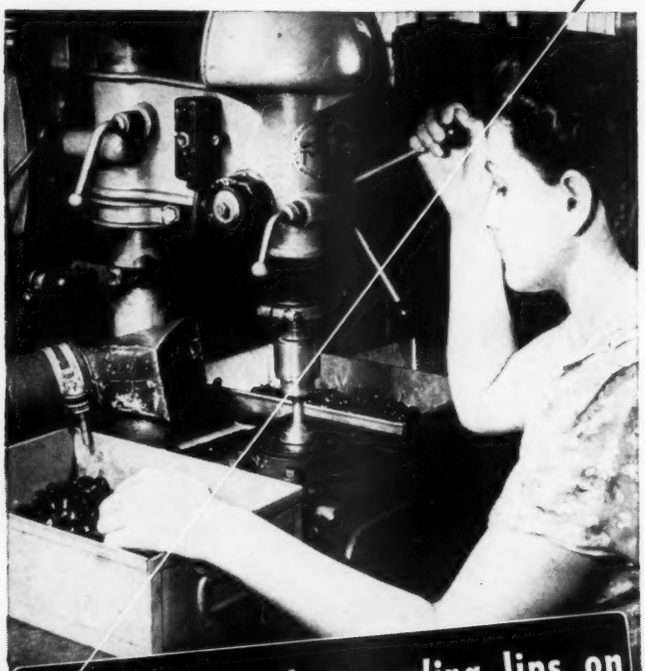
TUBE DIVISION

CALUMET & HECLA CONSOLIDATED COPPER COMPANY

Individually

PRECISION GROUND



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HERE'S a new ruling pen you will be proud to own—a ruling pen designed by Bruning craftsmen to be perfect in every detail. We believe you will find it different from any ruling pen you have used. Here's why—

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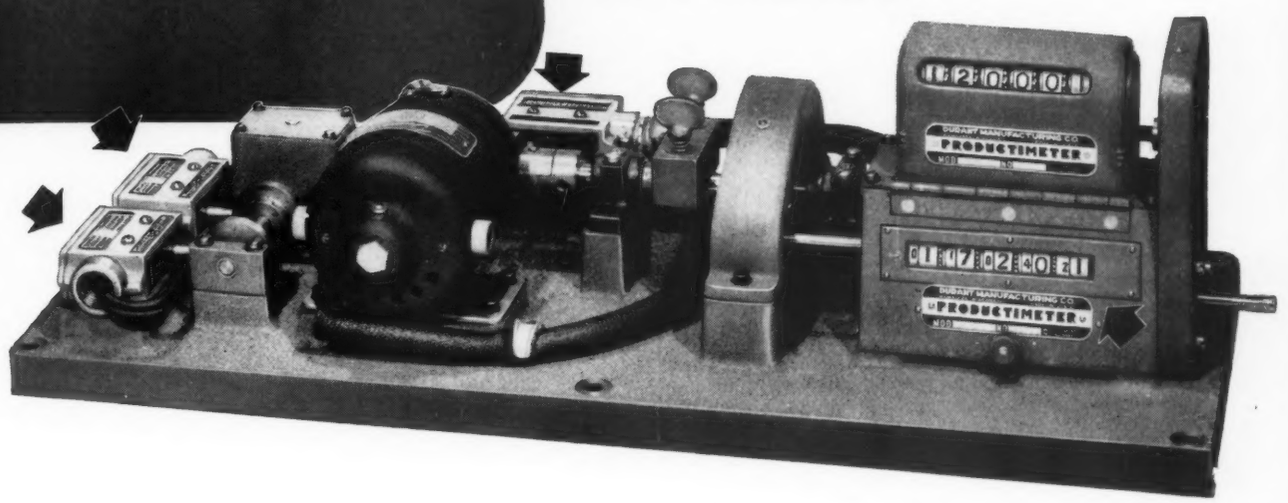
operate auxiliary wire cutting and reeling equipment...and reset this PRODUCTIMETER in 4 seconds



For sixty odd years the Durant Manufacturing Company of Milwaukee, Wisconsin, has been engineering and manufacturing rugged industrial type counters.

Durant has always been insistent upon quality of the parts which go into their product. Their use of Micro Switches in this Motor Reset Productimeter is a typical example of their fine engineering.

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One of the Metal Clad Micro Switches shown adjacent to the motor operates a flying shears which cuts the cable. Another controls the mechanism which leads the severed ends into a waiting reel. The third starts the reel winding when it is set and ready to go.

This is but another example of the wide range of application, precision, speed, long life and absolute dependability of Micro Switch. It is typical of the vital role which Micro Switch is playing in industrial machinery of every type and kind.

New products now being designed will use hundreds of Micro Switches in hundreds of different ways. For Micro Switch can be built to meet any specifications required. The basic Micro Switch is only 11/16" x 27/32" x 1 15/16", and weighs less than an ounce. Thousands of special housings, actuators, and electrical characteristics are available now, and new features are being added every day.

Let Micro Switch engineers help you solve your design problems that call for the unusual in precision switching.

The basic Micro Switch is a thumb-size, feather-light, plastic enclosed, precision snap-action switch that operates on force differentials as low as ¼ ounce and movement differentials as low as .0002". It is listed by the Underwriters' Laboratories with ratings of 1200 V.A. loads from 125 to 460 volts A.C. It can be supplied in a wide variety of housings and a broad range of actuating mechanisms.

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WANTED

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We have two interesting openings for men with the "know-how" to supervise and get things done. Both positions are in the Production Development Section of our General Lamp Engineering Group and offer excellent long-term opportunities to men with real ability.

FOREMAN POSITION #1—Direct and supervise activities of Equipment Development Machine shop. Supervise construction and do some design on machinery used in pilot plant manufacture of our lamp products.

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Applicants should be graduate engineers or have equivalent experience. Previous lamp experience highly desirable but not essential.

Mail brief statement covering education, training and experience and salary requirements. Interviews for qualified applicants will be conveniently arranged in either our New York, Boston or Salem offices.

Sylvania Electric Products Inc.

Industrial Relations Department

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By Rubber and Plastics Machinery Manufacturer

A designer with fundamental engineering knowledge and plenty of imagination. Adequate salary and opportunity.

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See Additional Position Vacant Ads On Opposite Page

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who knows

PORTABLE AIR COMPRESSORS

Nationally known equipment manufacturer, now 100% in war work, seeks high grade man for position of Assistant Chief Engineer in Compressor Division. Exceptional opportunity with ASSURED POST-WAR FUTURE. You'll be interested when you learn the details.

Our engineers have been notified of this advertisement. Write freely, giving your experience and references.

Address **P-622**, Product Engineering
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Leading firm of British Engineers with Continental Sales Organization are prepared to negotiate for

EUROPEAN POST WAR RIGHTS
of manufacture of
LIGHT AND MEDIUM ENGINEERING UNITS
Full particulars in confidence to
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1¼ inch valve as above, 40 lbs. each...$25

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Generating Plants. Diesel, Natural Gas or Steam Engines. Reconditioned Pipe, Valves and Fittings. High Tensile Steel Rods. Contact us before you buy.

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A-14-1

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1 Electrical

1 Mechanical

NEEDED NOW

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The positions are with an alert and progressive manufacturer now engaged in vital war work and long recognized as a peacetime leader in its field.

Congenial working conditions in a pleasant community forty miles from Chicago. Send us your complete background; we will hold it in strictest confidence.

P-624, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

WANTED

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For Outstanding Opportunities

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These jobs are not temporary, but definitely permanent positions. Engineers, with an eye to the future, may find one of these positions just what they're looking for.

Please give a full resume of education, experience, and date available. All replies will be held strictly confidential.

P-618, Product Engineering
330 W. 42nd St., New York 18, N. Y.

WANTED

DESIGN ENGINEERS

Are you in an industry and associated with a company that is going places after the war?

Here at SYLVANIA ELECTRIC PRODUCTS, INC. are opportunities for capable design men to make a direct contribution to the winning of the war as well as establish for themselves a real post-war opportunity.

We need THREE MECHANICAL DESIGN ENGINEERS.

ONE ENGINEER to design equipment to be used in the production Development Section for pilot plant manufacture of new products.

ONE ENGINEER to design and develop lighting fixtures from mechanical engineering standpoint.

ONE ENGINEER to design marine lighting used on instruments and control boards. Requires contacting sub-contractors and knowledge of metal casting.

Applicants should be graduate mechanical engineers. Previous related experience desirable but not essential.

We have, in addition to the above positions, openings for draftsmen and mechanical engineers interested in production and equipment design.

Mail brief statement covering education, training and experience and salary requirements. Interviews for qualified applicants will be conveniently arranged.

Sylvania Electric Products Inc.
Industrial Relations Department
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There *are* only a few of the sort we want. They're engineers . . . men with a solid, expert background in mechanical design . . . men who aren't hidebound in their thinking.

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WANTED

PRODUCT ENGINEER

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P-619, Product Engineering
520 North Michigan Ave., Chicago 11, Ill.

WANTED

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P-607, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

WANTED

MECHANICAL ENGINEER

for development work with a small company located in a small town in Western New York. Permanent place for the right man—on war work now, with post-war work waiting.

P-621, Product Engineering
330 W. 42nd St., New York 18, N. Y.

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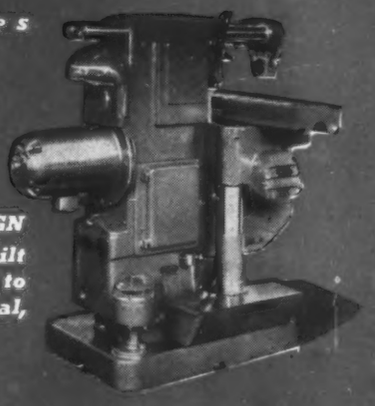
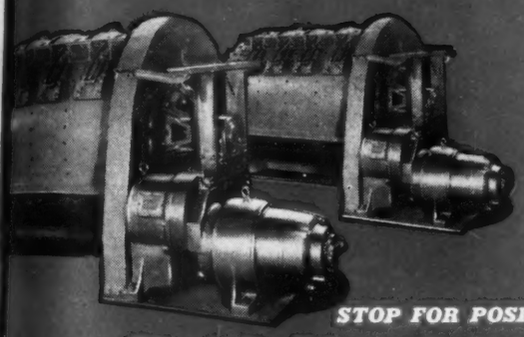
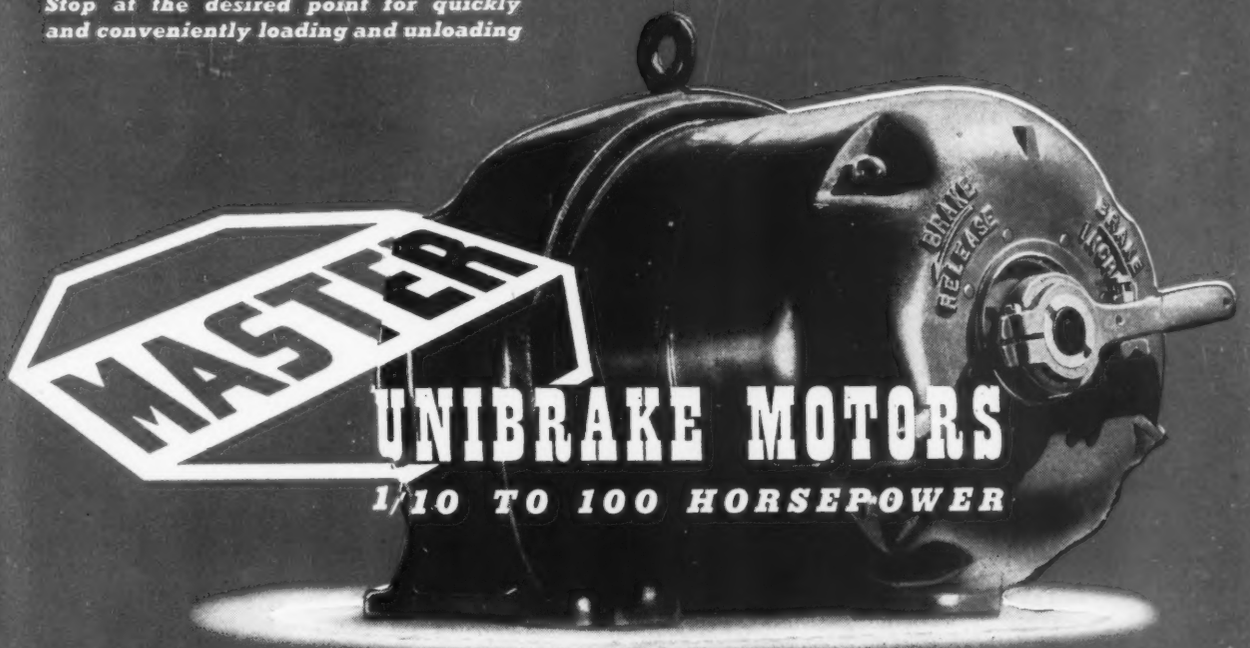
BUY UNITED STATES WAR BONDS AND STAMPS



SIMPLE COMPACT DESIGN
The electric brake is built into the motor end cover to form a compact, economical, easy to use unit.



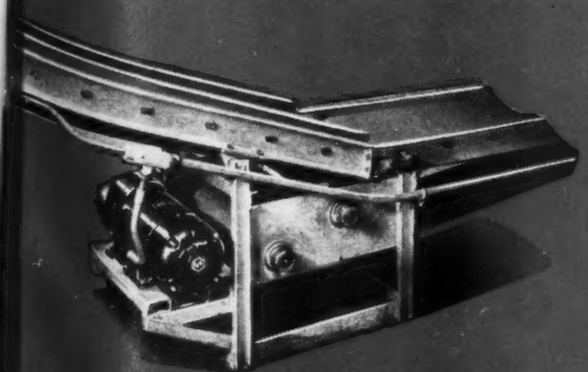
STOP FOR POSITION
Stop at the desired point for quickly and conveniently loading and unloading



UNIBRAKE MOTORS

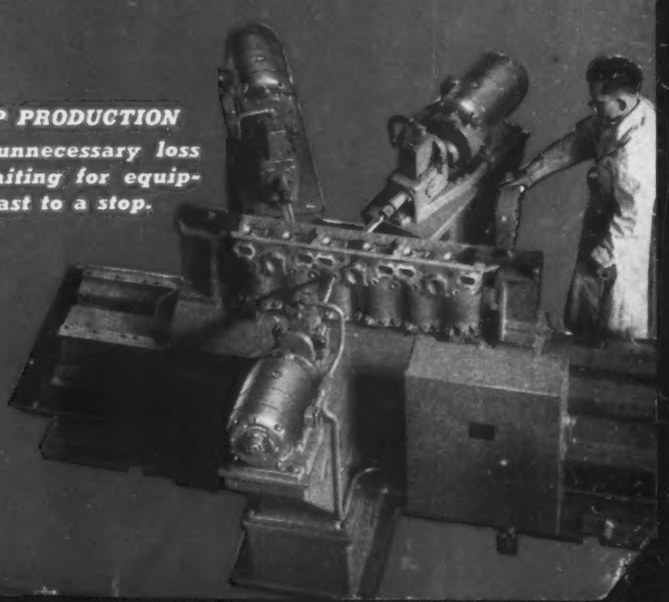
1/10 TO 100 HORSEPOWER

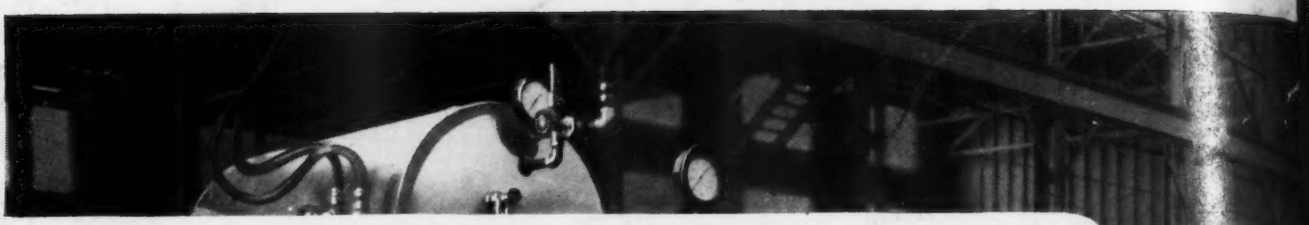
THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO



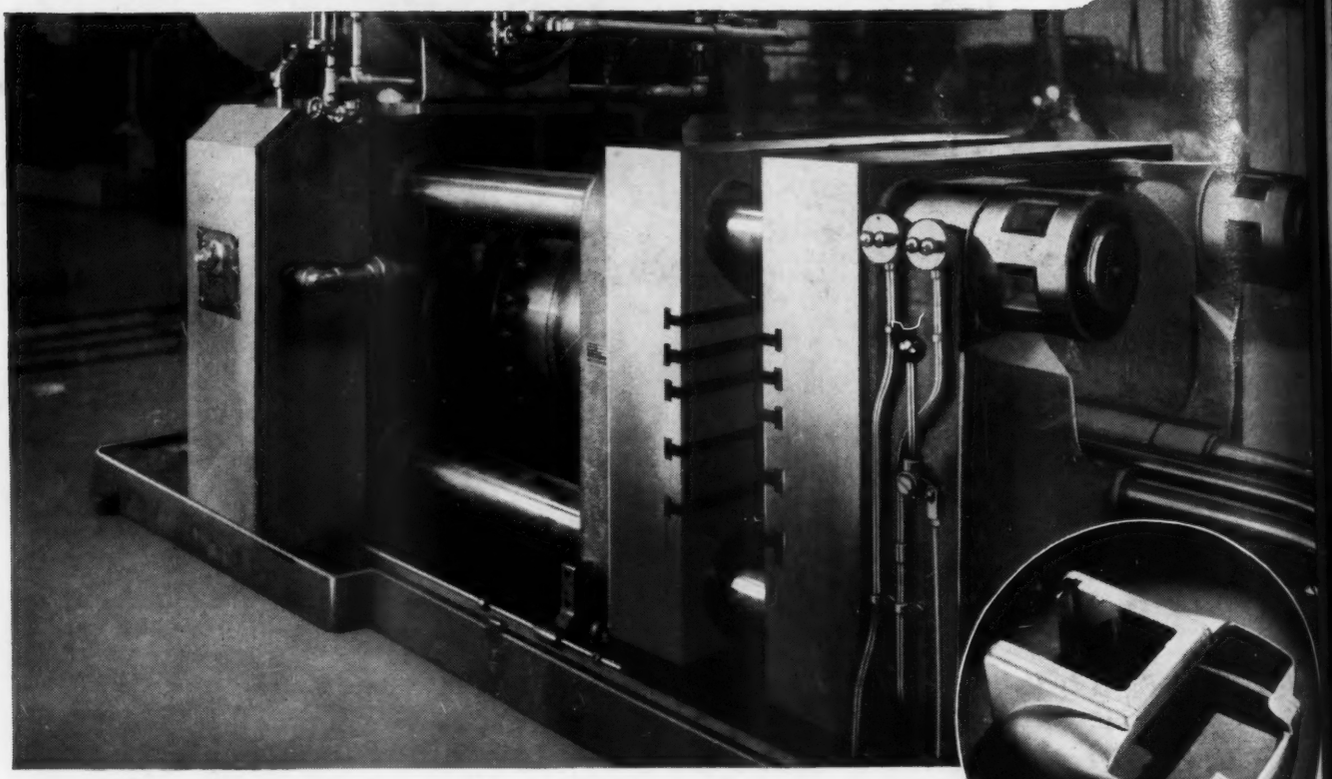
STOP AND HOLD ANY LOAD
Unibrake motors are very advantageous on hoists, elevators, inclined conveyors, etc....

SPEED UP PRODUCTION
Eliminate unnecessary loss of time waiting for equipment to coast to a stop.





A DOW MAGNESIUM SERVICE — DIE CASTINGS



Experience — Technique — Equipment

Advancements in the techniques of die casting Dowmetal Magnesium alloys are an integral part of Dow's long and intimate association with magnesium.

Magnesium Die Castings made by Dow offer such advantages as low cost in quantity production, dimensional accuracy, weight saving by ability to cast thin sections and decrease in machining.

Long experience has made Dow the recognized source of authentic information on magnesium—covering a range from ingots to finished products. Regardless of the form of fabrication, if this weight-saving metal is to be used, consult Dow.

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New York · Cleveland · Chicago · St. Louis · Houston · San Francisco
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